The Journal

OF THE

AMERICAN DENTAL ASSOCIATION

CONTENTS

James E. John, D.D.S. ..... Frontispiece

ORIGINAL COMMUNICATIONS

Fractures of the Mandibular Condyle.
Adolph Berger, D.D.S. 819

Intra-Oral Open Reduction for the Management of Certain Difficult Fractures.
William L. Shearer, M.D., D.D.S. 833

Dentigerous Cyst in the Maxillary Sinus Containing an Unerupted Third Molar: Report of Case.
Bernard J. Cipes, D.D.S., and Byron B. Kenyon, M.D., F.A.C.S. 835

Relationships Between Blood Agglutinins for Oral Lactobacilli, Salivary Counts and Caries.
Victor H. Dietz, A.B., M.S., D.D.S.; Ned B. Williams, A.B., D.D.S., and William E. Lawton, B.S., D.D.S. 838

Continuous Deposition of Cementum.
Bernhard Gottlieb, D.D.S. 842

Habits and Their Relation to Malocclusion.
Leland R. Johnson, D.D.S., M.S.D. 848

Base Metal Alloys for Oral Restorations.
George C. Paffenbarger, D.D.S.; H. J. Caul, B.S., and George Dickson, M.A. 852

Plumbism: Report of Case.
Alvin T. Levy, B.A., M.A., D.D.S. 863

Scientific Method in Dentistry: An Original Formula for Its Application.
Victor H. Sears, D.D.S. 864

Recovery of Ameloblasts.
Joseph P. Weinmann, M.D. 874

The Rôle of New Vitamin-Like Activator in the Control of Dental Caries.
Weston A. Price, D.D.S., M.S. 888

Combined Intra-Oral and Dental Fixation in Fracture of the Mandibular Angle with Considerable Displacement.
Erwin W. Ferber, D.D.S., M.S. 906

X-Ray Irradiation in Facial Cellulitis.
Peter J. Kapo, M.D., F.A.C.R., and E. Harry McCue, D.D.S. 910

Effects of Estradiol, Testosterone, Diethylstilbestrol and Several of Their Derivatives upon the Human Oral Mucous Membrane.
M. J. Richman, A.B., D.D.S., and A. R. Abarbanel, A.B., M.D. 913

Conservative Treatment of Vincent's Stomatitis.
A. Bernard Eskow, D.D.S., and Daniel Elihu Berman, D.D.S. 924

EDITORIAL DEPARTMENT

The Council on Dental Therapeutics 926

High School Victory Corps 929

Bibliographical 931

ASSOCIATION ACTIVITIES

Bureau of Public Relations—Council on Dental Therapeutics—Membership Page—Council on Dental Education—Committee on Legislation ..... See Special Contents for Association Activities, page 935

OBITUARIES

William Hoffman Gardiner Logan, D.D.S., M.D., LL.D., M.S. (1873-1943) 968

Addison K. Parks, D.D.S. (1875-1943) 971

Deaths 971

Current Literature 973

Announcements 976

ADVERTISEMENTS

Index to Advertisements A-59

Classified Section A-48

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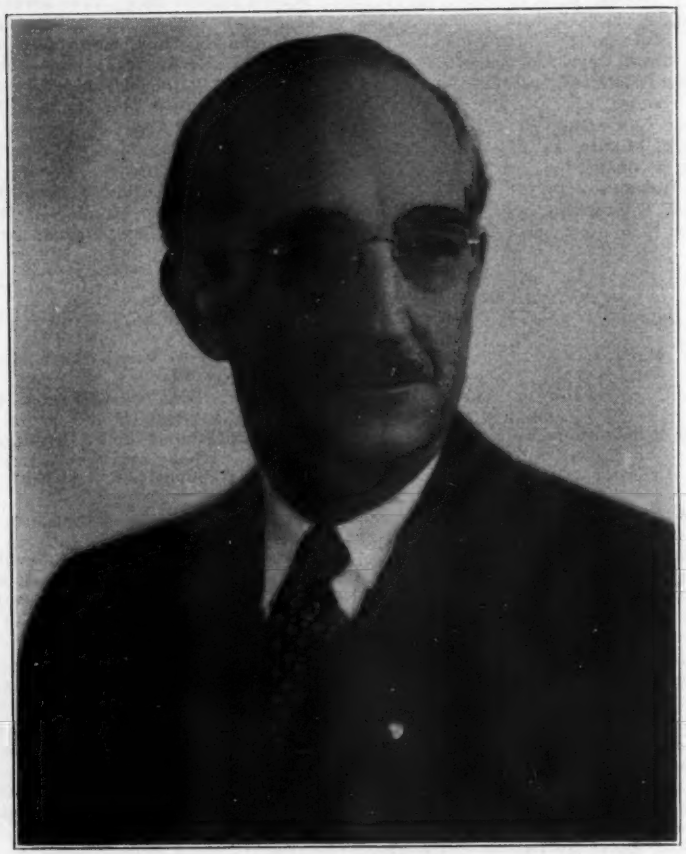

JAMES E. JOHN, D.D.S., Roanoke, Va.
Chairman, National Board of Dental Examiners

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FRACTURES OF THE MANDIBULAR CONDYLE

ADOLPH BERGER, D.D.S., New York, N. Y.

UNDER the heading "Fractures of the Mandibular Condyle," there will be considered those fractures of the mandible in which the articular head of the condyle is separated from the ascending ramus. The line of fracture in these cases frequently passes through the mandibular notch to the posterior border of the ascending ramus. Many occur above this landmark. Fractures located below the mandibular notch are more appropriately designated as fractures of the ascending ramus.

Fractures of the condyle are not so common as are those which occur in other parts of the mandible. They are not so rare, however, as was believed at one time. Their greater frequency may be attributed, at least in part, to the fact that automobile and industrial accidents, often responsible for these fractures, were not so prevalent one or two decades ago as at present. Furthermore, if there is no marked displacement of the fragments, the symptoms, signs and discomfort may be so slight as to be easily overlooked.

From the Oral Surgery Department, School of Dental and Oral Surgery, Columbia University, and Hospital for Joint Diseases.

The ascending ramus proper is clothed externally by the masseter mscle, the parotid gland, the deep and superficial fascia and the integument. Because of this abundance of covering, these parts are not freely accessible to diagnostic manipulation. In the presence of contusion, and especially swelling, palpation is of little aid. Such pathognomonic signs as crepitation and false point of motion are not easily elicited. Furthermore, when there are one or more fractures in parts more easily observed, attention may be concentrated upon those injuries.

The literature treating with these fractures is not so ample as that which deals with fractures in other parts of the mandible. Most published articles are based upon the treatment of one or only a few cases and essentially bear the pattern of such limited experience. A study of a larger number of cases discloses that these, like other fractures, cannot be treated categorically. They are in many essential respects not alike. Important variations are found in the line and point of fracture, in the displacement of the fragment, in the deviation of the dental arches from normal relationship, in the degree of deformity

and in the nature and degree of disturbed function.

Fractures of the condyle may be unilateral or bilateral. Bilateral implies here that both condyles are fractured. In either event, there may be one or more fractures on the same side, or on the opposite side.

ETIOLOGY

The cause is always some external violence, which may be direct or indirect: a fist blow, a kick, a fall, a blow of a missile or implement, automobile, elevator or industrial accidents, some crushing force, etc.

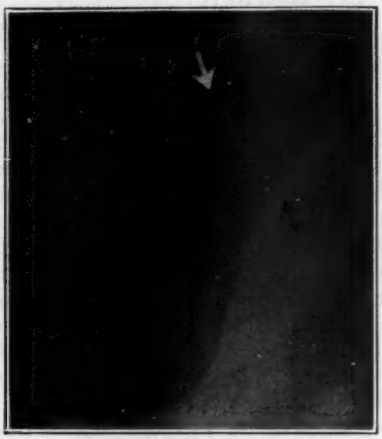


Fig. 1.—Simple line fracture without displacement of parts. There is no disturbance in the anatomic relationship or in the occlusion in cases of this type and little if any interference is indicated beyond periodical observation for ten or fourteen days.

Direct trauma is sustained upon the injured side. Indirect trauma is delivered to the opposite side, or upon the chin. In bilateral fractures, the blow is often transmitted from the chin.

SYMPTOMS AND SIGNS

Clinical signs of fracture of the condyle may be entirely lacking, so slight as to be easily overlooked or quite marked. Some are revealed only by roentgenograms. The nature and degree of the clinical signs and symptoms are determined partly by the disposition of the fragments. Nevertheless, there is a great latitude of individuality in this respect.

It is a natural expectation that the relationship of the fragments should determine the approximation of the teeth and influence the articulation of the joint. This is not always true. In a number of cases observed, the occlusion of the teeth remained normal and function of the joint was not seriously and only temporarily impaired, despite the fact that there was displacement at the point of fracture, and coaptation of the broken surfaces was inaccurate.

When displacement is slight or the bone is merely cracked, as seen in Figure 1, there may be no clinical signs beyond the outer contusion, and little or no dental deformity.

In unilateral fractures, the clinical sign most frequently observed is a shift in the line of occlusion toward the injured side. The length of the ascending ramus being shortened by angulation, impaction or overriding of the fragments, the arc of excursion is also shortened in a geometric ratio, and the mandible is drawn toward the injured side. The shift is observed when the mouth is opened or closed. The ramus being shortened, when brought into apposition, the posterior teeth on the injured side make contact first. Usually, there is a gap between the anterior teeth and, to a lesser degree, between the teeth on the opposite side. (Fig. 2.)

The bilateral condyloid fractures that have come under my care or observation were caused by indirect force. Two cases occurred in automobile collisions. The chin struck against the steering wheel and both condyles were fractured. (Figs. 3 and 4.) In both of these cases, a third line of fracture occurred at the median line. One bilateral fracture occurred in a child 4 years old (Fig. 5) who fell

Fig. 2.—Case illustrating number of important points. The patient, aged 32 years, was run down by a taxi cab. The injury was a double fracture, one at the base of the left condyle and the second through the mental foramen on the right side. Above, left, condyle fracture, showing angulation. The head of the condyle is dislodged from the mandibular fossa and the capsular ligament. There is a V-shaped gap between the anterior teeth. The contact of the posterior teeth is to be noted. Below, left, adjusted position of condyle with complete reduction of arches and immobilization with intermaxillary wiring. Above, right function with mouth open. Below, right, discrepancy in occlusion from seven to eight months later. The patient had been removed from the author's care and the wires were prematurely removed by some one else. Muscular traction caused the displacement, which was not corrected. (This case emphasizes the fact that all patients should be kept under observation for from four to five weeks after immobilization has been discontinued and, if the occlusion is not restored, function may be permanently impaired. In this instance, it implied refracturing and resetting the jaw.)

down stairs and struck and lacerated his chin.

The deformity and also the displacement of the fragments in bilateral fractures are not alike on the two sides. The common finding is that the mandible, having lost its posterior supports, is drawn backward and upward by muscle traction, and there is a V-shaped gap between the anterior teeth. At the median fracture, the discrepancy in the alinement of the teeth may be marked or there may be only a slight separation of the fragments.

In several cases, bleeding from the external ear occurred. It is likely that, in

Fig. 3.—Bilateral fracture of condyle sustained in automobile collision. The chin struck the steering wheel. A third fracture occurred at the median line. There was marked displacement of the parts. Above, points of fracture and angulation of fragments. Below, photographs taken about six months after patient was dismissed. They show no facial deformity, with the mouth open and the teeth in occlusion, respectively.

these cases, the tympanic plate was ruptured. Such bleeding is to be differentiated from that caused by skull fracture. In two cases, the hearing was temporarily diminished. A partial obstruction of the meatus from indentation may be the explanation.

A man, aged 58, sustained a bilateral fracture of the condyles and a fracture of the body of the mandible in an automobile accident. Both condyles were completely dislodged beneath the internal pterygoid muscles. The stump end of the left ramus broke through into the auditory canal. There was considerable suppuration through the external ear.

An important diagnostic method for these fractures, worthy of being stressed, has to the best of my knowledge not yet been described. No mention is made of it in the literature. This sign is observed in the external auditory canal with the palpating finger. For comparison, the two index fingers should be placed one in each auditory canal. Normally, the condyle can be clearly felt here when the mouth is opened and closed. In fact, these movements can be more distinctly followed here than with external palpation. When a fractured condyle is dislodged from the mandibular fossa, these

A B

Fig. 4.—Bilateral fracture of condyle. As in Case 3, this injury was sustained in an automobile collision, the chin striking the steering wheel. A third fracture was at the median line. A, fractured-off condyles completely dislodged, appearing within curve of mandibular notch. They were left in this position and no untoward complications developed. The fractured stump ends are to be noted. The patient was wearing two partial dentures. There were only a few available teeth; which made reduction and mobile fixation difficult, as there was marked backward displacement and the characteristic V-gap. B, photograph taken about one year later. There was no facial deformity and function was normal. The patient is wearing the dentures which he had before the accident.

One of the important clinical means of diagnosing these fractures is palpation of the head of the condyle in motion. When the overlying tissues are swollen, these movement are difficult to discern. Under normal conditions, however, the moving condyle can be distinctly felt as it rides from the mandibular fossa toward the articular eminence. movements are less distinct. When it is dislodged from the capsular ligament, the bulge of the articular head is entirely lacking. Traction of the soft tissues may be felt, but this can be distinguished with trained perception.

When there are no other clinical signs and the roentgenogram is obscure, or

not obtainable, this finding may be regarded as a positive sign of fracture of the condyle. Exceptions are, however, those conditions wherein there is merely a line of fracture as shown in Figure 1 or the condyle remains within the capsular ligament and the mandibular fossa, even though in a tilted position. (Fig. 6.)

LINE OF FRACTURE AND DISPLACEMENT OF THE FRAGMENTS

The nature of the displacement of the condyle can be determined by several conditions. Of these, there may be mentioned the severity of the trauma and the direction of its impact, the nature of the traumatizing agent, the point of fracture, the muscle attachments and their traction, the functional leverage, the form and size of the condyle and the depth of the mandibular fossa, the proximity and protrusion of the articular eminence, the occlusion of the teeth and their position at the critical moment. Each of these conditions plays a decisive part in this respect.

It is notable, however, that, in bilateral fractures, in which conditions should be equal, the line of fracture and the displacement of the fragments are not parallel. (Figs. 3, 4 and 5.)

The line of fracture may be through the base of the articular head (Fig. 7), through the surgical neck or lower down. The direction of the line of fracture may be horizontal or diagonal (Fig. 8, A, B, C), and occasionally the ramus is split vertically to its lower border. (Fig. 8, D.) In many diagonal fractures, the line of fracture passes from the mandibular notch diagonally backward, the fragment carrying with it a portion of the ascending ramus, as shown in these illustrations. Comminution is comparatively rare. Several comminuted fragments, if the fracture was not compounded primarily and remained simple, united uneventfully.

Every case should therefore be studied from these various angles. Special consideration should be given to those points that may bear upon treatment of the case.

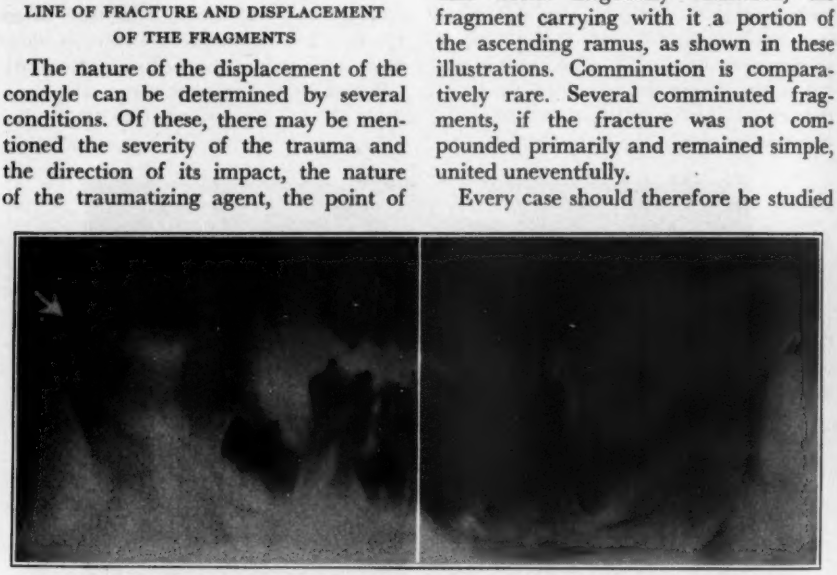


Fig. 5.—Bilateral fracture in child aged 5 years; showing displacement of both condyle heads. Upon cicatrization, there was no deformity and good joint and dental function. (This case will be followed up to a stage of adolescence, if possible. It will be of interest to note whether the injury influenced the growth of the mandible and, if so, to what extent.)

Where there is none or only slight displacement, the head of the condyle may be retained in its normal position. In some cases, it is tilted or is forced into torsion. The tilt may be backward and outward or inward, forward and inward or outward. At the line of fracture, there may be angulation, overriding and occasional impaction.

The head of the condyle may or may

not remain in the mandibular fossa. It may be dislodged or tilted in some direction, but still remain within the capsular ligament, with alteration in the relationship of the articular surfaces. In still others, the roentgengram shows that the head has broken through the capsular ligament and is completely outside the mandibular fossa, even during function, and may remain permanently fixed in this new position.

In several cases, the fractured off portion was forced some distance from its normal position and was lodged underneath the muscles, or in some tissue spaces. (Figs. 4 and 5.) In one case noted, the fractured off head was forced into the sphenomaxillary fossa. (Fig. 9.)

It is believed, and sometimes stated,

Fig. 6.—Diagonal fracture with forward and outward tilt, with marked overlapping at line of fracture. The head of the condyle is retained in the mandibular fossa and within the capsular ligament.

that these detached fragments may become necrosed or otherwise cause untoward complications. In the several cases observed, nothing of this nature occurred. Whether this fragment becomes encapsulated or eventually resorbed has not been as yet determined.

ROENTGENOGRAMS

Roentgenograms are always to be depended on in the diagnosis of fracture. Clear cut roentgenograms of these parts are difficult to obtain because of the overlapping of the opposite side, of the vertebrae, the mastoid process, the thyroid cartilage and other structures within the area. It is best to take lateral plates with the mouth partly open and with such angulation that overlapping may be avoided. Where the mandibular arch is narrow, overlapping of the opposite side is difficult to avoid.

In viewing the roentgenograms, the graceful outline of the posterior border of the ascending ramus terminating in the head of the condyle should be especially studied. Any break in the continuity of, or the slightest angulation along, the posterior border is a positive sign of a fracture. (Fig. 10, A, B.)

Sometimes, where the lateral plate is obscure, an anteroposterior exposure, such as is taken in diagnosing the maxillary sinus, will disclose more clearly the fracture and the displacement of the fragment. (Fig. 10, A and B are the same fracture.)

TREATMENT

In planning the treatment, accurate diagnosis regarding the following considerations is essential: the displacement of the fragments, the extent and the nature of the misalinement of the teeth, the direction and the amount of force necessary to restore the former occlusion of the teeth, the number, distribution and condition of the teeth, the extent to which they may be utilized for traction and fixation and the nature and degree of disability in opening and closing the mouth.

In some bones, it is essential to so reduce a fracture that the parts are brought into as nearly perfect alinement and coaptation as possible, for the best functional and esthetic results. This is not equally true of all bones.

In mandibular fractures, coaptation of the broken surfaces is desirable, but not absolutely essential for a good result.

Treatment should comprehend the following requirements: (1) restoration of

function; (2) correction of deformity, primarily for function, and to meet esthetic requirements, which, though highly important, are a secondary consideration, and (3) avoidance of methods of treatment which lead to complications. Among such complications would be considered infection, osteomyelitis, avoidable scarring, nerve injury and its sequelae and the formation of cicatrices, which may cause limitation of function and are difficult to correct.

The early restoration of the articulation of the teeth should be the first aim in the treatment of all fractures of the mandible. This is paramount. The functional and esthetic final results depend decisively more upon the occlusion of the teeth than upon the accurate coaptation of the broken surfaces. This can almost always be achieved without absolute coaptation of the fragments or aggressive complicating operations.

Even larger gaps between the fractured surfaces become spanned over by repair bone. Impacted or overriding bone surfaces unite without altering the facial outline and without impairing occlusion.

Where a large segment of bone is lost, as often occurs in war wounds, and not infrequently in civilian practice, the parts containing teeth should be brought into their former relative position. The original mandibular outline should be reconstructed completely where possible, or in part so far as the remaining tissues permit. Later, corrective measures with bone graft and prosthetic restorations can be taken more successfully under such conditions.

A B

Fig. 7.—A, fracture through base of neck. The fragment was dislodged from the mandibular fossa and there is overlapping. B, fracture of articular head with anterior displacement. This fragment blocked the movement of the mandible and was manipulated into position.

Where this important consideration is overlooked, secondary operations become necessary. The fundamental requirement in such operations is to bring the existing parts into their former position to obtain function and form.

REDUCING THE FRACTURE

Early reduction and immobilization are advantageous and, as a rule, can be accomplished more easily within the first

week after injury occurs. Very soon, adaptive and cicatricial contraction sets in, and this is not always easily overcome. When the patient is suffering from shock, concussion of the brain or such injuries as prohibit immediate interference, improvement in this respect must be awaited.

In reducing these fractures, two distinct functions should be borne in mind: (1) free movement at the temporomandibular joint and (2) restoration of the occlusion of the teeth.

Function at the joint may be obtained without articulation of the teeth and, conversely, the articulation of the teeth may be restored without a functioning joint. These two essential considerations should be regarded, however, as one coordinated necessity.

Some patients can open their mouths freely. In others, movement of the mandible is halting or tardy. In still others, movement is abruptly retarded or may be completely blocked.

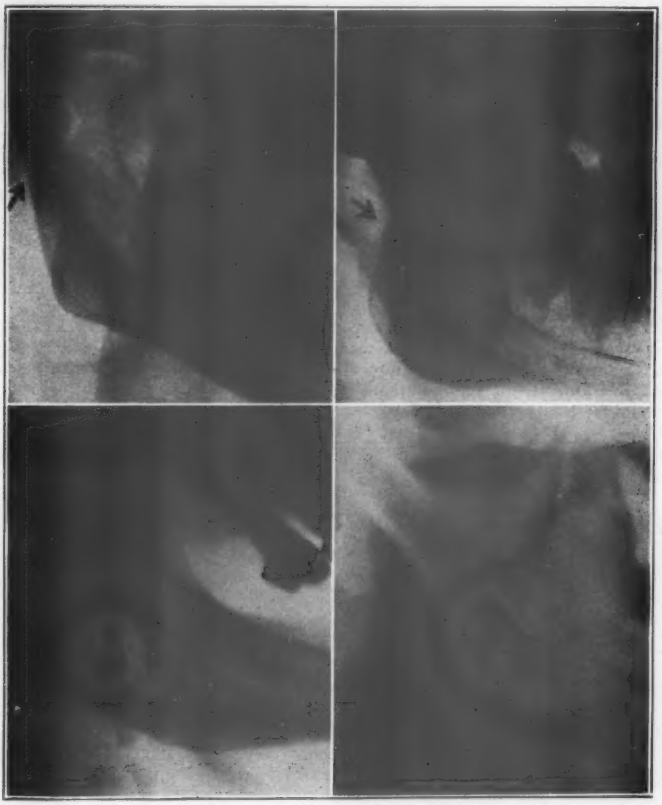


Fig. 8.—Above, diagonal fractures through mandibular notch including variable parts of ascending ramus. There is displacement in the right view. Below, left, diagonal fracture which passes from coronoid process to posterior border of ascending ramus. Below, right, line of fracture passing through base of coronoid process to lower border just anteriorly from angle of mandible. The degree of displacement can be best seen along the lower border anteriorly from the angle.

The nature and cause of these dis-

abilities should be carefully studied and scrutinized. It is essential to determine whether they are caused by traumatization of the soft tissues or whether the bone fragment blocks the movement of the jaw.

Halting or tardy opening of the mouth is usually caused by trauma and edema of the soft tissues. Under these conditions, the disability will correct itself with decline of the inflammatory processes. If the bone fragment acts as a block, limitation in the movement of the mandible is abrupt and unyielding or complete. In the treatment of these conditions, one of two measures may be adopted. The fractured condyle may be manipulated into such a position that the mouth can be opened and closed without impediment. This can frequently be accomplished with manual intra-oral and extra-oral pressure while the mouth is guardedly opened and closed. When contusion is marked and the pain entailed is severe, it is advisable to give the patient general anesthesia, inducing complete muscular relaxation. The aim should not necessarily be to achieve ac-

A B C

Fig. 9.—Fracture of articular head, in man aged 23, which was sustained through fall in skating. A, fractured off articular head forced into sphenomaxillary fossa, which blocked movement of mandible until it was manipulated into present position. B, C, result, no deformity, the mouth open and teeth in normal occlusion.

A B

Fig. 10.—A, unilateral fracture, in man aged 52, which was sustained from fist blow delivered on opposite side. The angulation at the point of fracture, A, is to be noted. B, same fracture with anteroposterior exposure. This is a more exact presentation of the position of the fragment.

curate coaptation, but rather to so alter the position and relationship of the fragment that it does not prevent opening and closing of the mouth.

If the fragment cannot be brought into a satisfactory position by manipulation, it should be removed completely by an open operation.

maintain it in place by transosseous wiring. Such fragments should be removed as early as possible when this course is decided upon and always before fixation.

From a study of a number of cases, some here presented, open reduction would be ill advised, if not impossible, even from a technical standpoint. In

A B C

Fig. 11.—Double fracture of mandible, in man aged 44, which was sustained through fall. A, head of condyle in anterior angulation, completely dislodged from mandibular fossa and capsular ligament. The second fracture was in the bicuspid area on the opposite side. The osseous union is shown in the roentgenogram. B, mouth open with a shift toward injured side. C, absence of facial deformity, with occlusion normal.

A B C

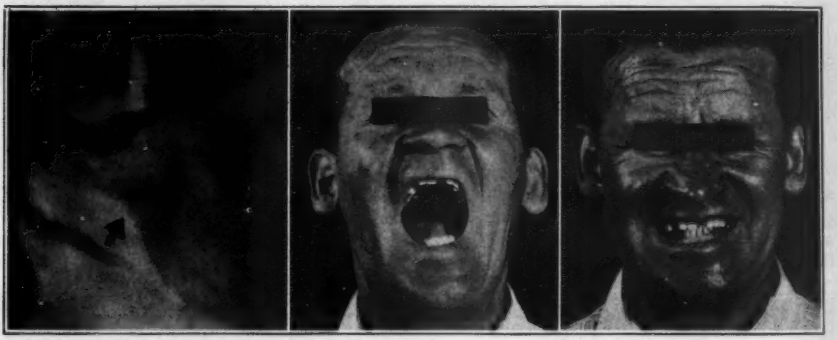
Fig. 12.—A, fracture of condyle in man aged 21, which was sustained from blow of fist. A portion of the ascending ramus is carried with the fragment. The head of the condyle is completely dislodged from the mandibular fossa with an anterior tilt and in torsion. B, C, mouth open and closed. There was no facial deformity.

From every standpoint, it is better practice to remove the fragment summarily than to attempt to restore and

an open operation, the jagged stump may be smoothed off, but even this is unnecessary. In my experience, the re-

sults of these measures have proved to be altogether satisfactory. That the parts have united in a false position is of no consequence. As shown here, function of the joint is free, the occlusion of the teeth is accurate and there is no scarring and no deformity. (Figs. 11, 12, 13, 14.)

If the condyle is completely dislodged, the condition is analogous to resection for bony ankylosis; with this difference, however, that, in adults, no deformity such as receding and undershot chin develops, as the mandible has attained its mature development. The effect in young growing children is still to be studied, as the epiphyseal growth of the ascending ramus must be essentially influenced, if not altogether terminated.



A B C

Fig. 13.—Double fracture of mandible in man aged 46, sustained from blow of fist. These roentgenograms and photographs were taken about six months after the patient was dismissed. A, displacement of condyle with anterior angulation. The head of the condyle is retained in the mandibular fossa and in the capsular ligament. Reduction and immobilization were rendered difficult because the patient was wearing a partial upper denture and there were very few teeth that could be utilized for the purpose. B, C, absence of facial deformity, mouth open and teeth closed.

ANKYLOSIS

Ankylosis is frequently spoken of as a sequence of the treatment of these fractures. Experience gives no grounds for this conclusion. While such a possibility is conceivable, no bony ankylosis developed in this series. It is a matter for speculation as to whether the condition, where it developed, was true ankylosis, or the misplaced fragment, acting as a block, was responsible for the disability.

IMMOBILIZATION OR FIXATION

It is axiomatic that fixation should not be carried out before function at the joint is established. If the mouth can be opened and closed before fixation, a good result can be expected.

Immobilization can be based upon three different principles, generally speaking: (1) immediate reduction and complete fixation; (2) delayed or gradual reduction with traction and complete fixation, and (3) incomplete or mobile fixation, with intermaxillary traction.

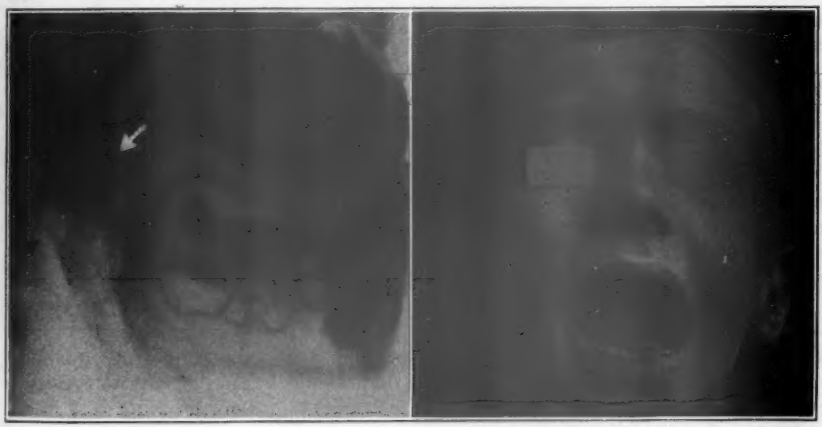
If the joint is mobile or mobilized so that the mouth can be freely opened and closed, immediate complete fixation is indicated. This can be achieved by one of the various methods of intermaxillary wiring, which scarcely require description here. In experience, if the patient is not exposed to transportation, and retching and vomiting are not anticipated, the simplest form of this measure will be most direct and effective.

If there is no actual blocking, but

there is a degree of tardiness due to edema or muscle traction, or the juxtaposition of the broken surfaces must be overcome, gradual traction may be applied. This can be accomplished by a few twists of the intermaxillary wires every twenty-four hours, if the separation of the teeth is only a few millimeters, so that wiring may be applied.

Where the separation of the teeth is marked, so that they cannot be brought together by finger pressure, traction with intermaxillary elastic bands should be provided.

Traction appliances should be of the type which cause the least damage to the soft tissues.



A B

Fig. 14.—Case of child, aged 5 years, who was run down by an automobile. There were severe lacerations about the face. Several of the teeth and the alveolar process at several points were fractured. Splints were used with traction to bring about a satisfactory relationship of the jaws. A, diagonal fracture with marked anterior angulation, head of condyle being thrust forward. B, photograph taken about two and a half years after accident. There was no marring of the face and function was satisfactory. With the eruption of the permanent teeth, the occlusion may be the same as though the accident had not occurred. There is, however, apt to be an underdevelopment of the injured ramus.

periodontium. Some arch wires that have been introduced within recent years for the treatment of fracture cause irreparable damage to the gums, which often results in premature loss of the teeth. Concentration upon treatment of the fracture is necessary. Nevertheless, biologic and physiologic understanding dictates the importance of preservation of the teeth as nearly intact as possible without marring their attachment.

Intermaxillary traction for delayed reduction with rubber bands has been employed for many years. If delayed or gradual traction is indicated, this principle is sound and the procedure is meritorious. On the other hand, when used for immediate complete fixation, where traction is not necessary and mobility offers no advantages, it is misapplied. These appliances, with the large number of rubber bands, can be unclean beyond measure and damaging to the soft tissues.

Elastic traction can be used with great safety and effectiveness when splints provided with lugs for the application of rubber bands are used. They can be cemented or attached by apposition to the teeth proper without infringing upon the gums. They are more stable than are wire arches and can be applied also

in sectional units for which wire arches are but poorly adapted.

OPEN OPERATIONS

Open reduction of these fractures is rarely necessary and not always successful. In fact, it is, as a general rule, contraindicated because of the precariousness of the result and the possible complications. The simple fracture is transformed into a compound one. Transosseous wiring often leads to infection and necrosis. The protracted suppuration which attends it is followed by scarring and cicatricial ankylosis, which is difficult to correct. Severing or traumatization of branches of the facial nerve is unavoidable and partial temporary or permanent paralysis of the muscles of expression often follows. From a study of the various fractures, such reduction can be technically a physical impossibility.

Because of the satisfactory results, manipulation, closed reduction and intermaxillary immobilization constitute the method of choice for treatment of these injuries.

To obtain union of the fractured bone alone is not sufficient. Unlike other bones, which serve in the main as the framework of the body, the mandible and the maxillae serve in a specialized capacity by virtue of the fact that they contain the teeth, organs of mastication directly bound up with the nutrition of the organism. If this requisite is not met in the treatment of a case, there is always some degree of deformity and the patient is functionally incapacitated. As a rule, later aid is sought to overcome or correct this deficiency. (Fig. 2.)

If open reduction is the best method to assure the result sought, surgical measures are admissible. On the other hand, when satisfactory or better final results can be obtained with manipulation and the use of appliances, their comparative simplicity should not discourage their use.

This point will bear emphasis because, within the last decade, numerous novel and mutilating surgical procedures and untried appliances conceived in the laboratory, and unproved practically, have been described and introduced to the profession. With few exceptions, these surgical and non-surgical methods will prove in practice veritable attempts to do a comparatively simple thing the hard way. We could well discount these laborious and often disappointing efforts were it not for the fact that poor judgment in this respect only too often redounds to the detriment of the patient.

War injuries or those occurring in industries are often so disruptive and mutilating that no standard or uniform method can be prescribed for their treatment. The measures ordinarily used successfully in simpler, civilian injuries are often inadequate. In such cases, the surgeon must use his ingenuity in the immediate surgical procedures. Furthermore, he should be prepared to serve as a guide in the construction of appliances which will complement the surgical measures.

The methods and means which will prove successful in the majority of cases should have the following qualities: they should be simple, easy to construct, efficient and expedient.

SUMMARY AND CONCLUSIONS

1. Fractures of the mandibular condyle are more common than they were one or two decades ago because industrial and automobile accidents are more common.

2. They are not to be categorically considered, as they vary in many respects. (Many displacements of fragments could not be shown for limitations of space.)

3. The diagnostic procedures can be amplified by palpating the condyles in the auditory canal.

4. Bleeding from the ear should be differentiated from that caused by a fracture of the skull.

5. Close attention should be given to the study of functional disability of the joint to determine whether it is caused by blocking of the fragment or edema and the inflammatory processes.

6. If the fragment prevents function, it should be forced into an acceptable position or removed.

7. Reduction or fixation of the condyle by open operation is not to be recommended because of possible complications and uncertainty of the result.

8. Fixation should be preceded by mobilization of the joint.

9. If the fragment is to be removed by open operation, it should be removed as soon as conditions permit, and before it has united in a false position.

10. Intricate appliances and measures may engage the imagination, but they can be the source of many complications and are at best not always so effective as are the tried and proven simpler methods.

11. Closed reduction with mobilization of the joint and restoration of the occlusion of the teeth are the keynote of success in the majority of cases. This article is based upon the treatment of from seventy-five to eighty cases of fracture of the condyle. Statistics available were omitted.

12. Patients should be kept under observation for from four to six weeks after fixation is discontinued. At this time, functional stress or muscle traction may act upon the callus, which is moldable at this stage. If displacement occurs, further fixation becomes necessary.

133 East Fifty-Eighth Street.

INTRA-ORAL OPEN REDUCTION FOR THE MANAGEMENT OF CERTAIN DIFFICULT FRACTURES

WILLIAM L. SHEARER, M.D., D.D.S., Omaha, Nebr.

WHILE there are many different procedures for management of the reduction and setting of fractures of the mandible, I wish to call attention to a procedure that I have employed for thirty-seven years.

The choice of anesthetic is important. Regional, local anesthesia is the anesthetic of choice in my hands. An incision is made with a knife on top of the ridge of the mandible extending from the third molar region on one side around to the third molar region on the other side. The buccal and lingual mucoperiosteal flaps are reflected down to the base of the mandible. In this way, all the blood vessels, nerves, veins and arteries are carried in the flap; which allows observation of the entire field. Holes are made with a drill through the body of the mandible on each side of the fracture. One must be sure that the holes are made in a strong part of the jaw and at least one-quarter inch or more from the edge of the fracture. Pure silver wire (the size one's judgment would indicate) is employed to hold the parts in position. If the fracture is slightly oblique, as it usually is, one can employ a circumferential wire which will keep the line of fracture from changing its position. One must be careful not to make the wiring too tight and thereby cause pressure necrosis.

Now the mucoperiosteal flaps are brought back into position and are closed

with an over-and-over whip suture. I prefer to start suturing in the median line, going back to the third molar and coming forward grapevine fashion to the median line, going back to the third molar region on the opposite side and coming forward in the same manner to the center, and tying. I prefer a horsehair suture. However, one may use the suture of his choice. At this stage, if the patient has been wearing artificial teeth, the dentures may be placed in the mouth to maintain vertical dimension. Then a plaster cast is made to fit the head and chin.

The usual procedure for making this cast is as follows: A stockinet is placed over the whole head and face, a bit of gauze being clipped to free the nares. A small amount of sheet wadding is placed on each side of the face. Now, with a 2-inch gauze, a bandage of several layers is made over the ball of the head around the sides of the face covering the ears and chin, being placed over the top of the head so that it cannot be removed. Then a plaster bandage is placed over the gauze bandage in like manner. The cast must be made sufficiently wide in front of the ears so that one may cut the cast away, freeing the ears. Now the cast may be cut away carefully over the ball of the head so that it may be slipped off and on as one desires. This makes it very comfortable for the patient to wear.

This cast is easy to make and costs very little, and its use precludes the possibility of the fracture's being pushed out of place by some little bump or by force exerted on the chin when the patient turns over in bed.

The cast is worn for about five or six weeks. When satisfactory union is obtained, one can make the incision in the same place as in the beginning: again reflecting the mucoperiosteal flaps as far as is necessary, clipping the silver wires and removing them, replacing the flaps and suturing.

This procedure has been employed with gratifying results with patients wearing either natural teeth or dentures. It is particularly indicated in fracture of the mandible when patients have lost all of their teeth. However, it is very successful when the remaining teeth are not strong enough to employ interdental wire splinting. It is understood that the mouth should be kept clean.

107 South Seventeenth Street.

Fig. 1.—Compound bilateral fracture of mandible.

Fig. 2.—After reduction.

DENTIGEROUS CYST IN THE MAXILLARY SINUS CONTAINING AN UNERUPTED THIRD MOLAR

REPORT OF CASE

BERNARD J. CIPES, D.D.S., Mount Vernon, N. Y., and
BYRON B. KENYON, M.D., F.A.C.S., Bronxville, N. Y.

History.—The patient, a college student, aged 20, presented himself at the rhinologist's office, April 21, 1942, complaining of a foul-smelling discharge into his mouth emanating from the upper third molar region.

Two months before, he had had a swelling and severe pain in this region and had gone to his family dentist for treatment. Dental x-ray films were taken (Fig. 1.) and he was told he did not have any third molar. The swelling was incised intra-orally, and a gauze drain was inserted and changed daily for several weeks. The swelling subsided, but a persistent foul discharge developed. He was then referred to the rhinologist.

Examination. — Nasal examination revealed, on the right side, swelling of the middle and inferior turbinate, with considerable creamy grayish pus exuding from the middle meatus.

Oral examination showed pus discharging along the distal surface of the upper second molar tooth. A probe inserted in the gingival fold in this region readily passed into the antrum.

Anteroposterior and lateral head roentgenograms (Figs. 2, 3 and 4) showed marked cloudiness in both antra, especially on the right; also non-aeration of the right anterior and posterior ethmoid cells. An unerupted molar tooth was disclosed well up in the right maxillary sinus.

Treatment.—The right antrum was irrigated and a foul exudate obtained. Subsequent irrigation through the nose did not aid in decreasing the quantity of exudate or in removing the foul odor.

May 15, the patient was referred to a dental surgeon for consultation.

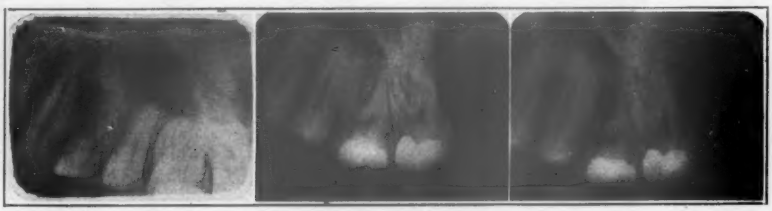


Fig. 1.—Upper third molar region.

Dental Examination.—The mouth was well cared for, but presented a foul odor coming from within the buccal cavity. The upper right second molar was tender on percussion. The gum about it was edematous. A probe passed easily under the loose gum margin distally from the second molar high up into the antrum.

The electric pulp tester was used to test the vitality of the teeth, which all responded normally with the exception of the upper right second molar. Here, no response was obtained. A dental drill was passed through the tooth and into the pulp. A putrescent pulp was found, with no sensation of pain.

Bacteriologic Examination.—Culture from the nose was reported as "Antral secretion, *Streptococcus viridans* predominating, with

a few *Staphylococcus aureus* present." Culture 2 from fluid aspirated from the antrum through the mouth fistula was reported, "No growth after forty-eight hours."

Operations.—After consultation, it was decided to remove the non-vital upper right second molar, in an attempt to reduce the infection present, before performing a radical antrum operation.

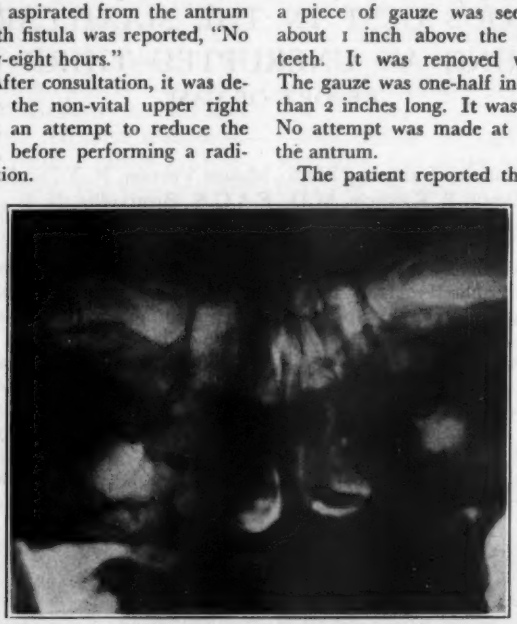


Fig. 2.—Anteroposterior view, showing unerupted third molar high up in right maxillary sinus.

Fig. 3.—Anteroposterior view, showing unerupted third molar high up in right maxillary sinus.

June 11, under local anesthesia (posterior-superior alveolar block), the second molar was removed. There was little remaining bone support. A large opening was found directly into the maxillary sinus. On examination with an illuminated mouth mirror, a piece of gauze was seen in the antrum about 1 inch above the root ends of the teeth. It was removed with an explorer. The gauze was one-half inch wide and more than 2 inches long. It was foully putrescent. No attempt was made at this time to curet the antrum.

The patient reported the cessation of the discharge and the disappearance of the foul odor within twenty-four hours. June 20, the patient was hospitalized and the following operation performed.

One-fourth grain morphine sulfate with

one-two hundred fiftieth grain hyoscine hydrobromide was administered hypodermically one hour before the operation. A cotton tampon saturated with 10 per cent cocaine adrenalin solution was placed in the inferior right meatus of the nose and left for ten minutes. The second division of the fifth nerve was then blocked intra-orally at the sphenomaxillary fossa, 2 cc. of a 1 per cent monocaine solution with adrenalin 1:75,000 being used. The block injection was supplemented by infiltration.

A horizontal incision was made beneath

Fig. 4.—Straight lateral film of right side confirming position of unerupted third molar as high up and also well back in maxillary sinus.

the mucobuccal fold, parallel with and three-fourths inch above the gum line, extending from the first bicuspid to the second molar. The mucoperiosteal flap was elevated and retracted well above the root ends of the teeth. An opening was chiselled into the antrum and enlarged with a Kerrison punch to about the size of a 25-cent piece. The entire lining of the antrum, which was enlarged and degenerated, was removed and held for examination. The crown of the unerupted molar was exposed in the point of the antrum highest and farthest back. The tooth was brought down with elevators and then delivered through the antral window with bayonet type thumb forceps. There was no evidence of perforation of the orbital floor. The usual counter opening in the naso-antral wall was made, but the inferior turbinate was left intact. No packing of gauze was used. The antrum was filled with sterile vaselin. The primary incision was closed with catgut sutures.

Outcome.—The patient made an uneventful recovery. Pulp test of the teeth one week after operation showed a normal reaction and all teeth comfortable.

Two weeks after the operation, the antral opening through the second molar socket had completely closed.

Pathologist's Report.—Infected dentigerous cyst was reported. (Examination at State Institute for the Study of Malignant Disease, Buffalo, N. Y.)

COMMENT

This case clearly demonstrates the inability to diagnose many oral conditions through the use of small x-ray films. Cysts and other pathologic anomalies may be overlooked, particularly in the upper third molar regions where superimposition of the coronoid process of the mandible and the zygoma makes correct diagnosis of dental films difficult.

Whenever a tooth is unaccounted for in the denture, large x-ray plates of the jaws and sinuses should be obtained. Closer cooperation between the rhinologist and the dental surgeon in all cases of sinus conditions of dental origin will make for a speedier end and better results.

RELATIONSHIPS BETWEEN BLOOD AGGLUTININS FOR ORAL LACTOBACILLI, SALIVARY COUNTS AND CARIES

VICTOR H. DIETZ,* A.B., M.S., D.D.S.; NED B. WILLIAMS,† A.B., D.D.S., and WILLIAM E. LAWTON,‡ B.S., D.D.S., Washington, D. C.

EVIDENCE was presented several years ago to the effect that lactobacillus agglutinins could be demonstrated in the serum of human beings who had received inoculations of heat-killed lactobacilli.[1] This preliminary work was followed by studies of the relationship between normal lactobacillus agglutinins of human beings and their caries experience.[2] It was found that the average agglutinin titer of thirty caries-free persons was 1:211, whereas thirty-one persons with active caries showed an average of 1:20. Corollary studies by Canby and Bernier[3] demonstrated that a diminution in the number of oral lactobacilli in salivary samples accompanied a change in the agglutinin titers. A reduction in the number of organisms in the mouths of nineteen of twenty patients followed repeated intradermal vaccination with heat-killed lactobacilli. A change in the blood agglutinin titer was associated with this reduction in the salivary count. Ten of the thirteen patients whose prevaccination and postvaccination serums were available showed increases in agglutinin titers. From these studies, it was found that thirteen caries susceptible persons showed prevaccination agglutinin titers which averaged about 1:80. In supplemental work, Fischer,[4] using the twenty-eight stock strains isolated by Canby and Bernier, found in three insusceptible patients blood agglutinins in titers of 1:160 to 1:320. Fischer also found that, in a single specimen of normal serum obtained from the heart of a *Macacus rhesus* monkey, all but one strain of the stock lactobacilli were agglutinated in appreciably high titers.

It is apparent that further studies should be instigated in order to obtain further evidence and substantiation of an immunologic relationship with dental caries. This brief review of pertinent papers indicates that the findings are of significant importance if the degree of caries susceptibility or insusceptibility is amenable to correlation with the blood agglutinin titer for oral lactobacilli. If this were true, it might be possible to ascribe to serologic phenomena some immunologic factor in caries experience. Previous workers have intimated that the presence of some obscure factor is revealed in the finding of higher agglutinin titers for oral lactobacilli in the blood of the insusceptible than in the susceptible. The immediate purpose of this paper is to present data obtained in an evaluation of the relationship between human blood agglutinins for certain selected strains of oral lactobacilli and caries experience.

MATERIALS AND METHODS

Patients.—All patients were examinees who presented themselves for the final

From the Department of Bacteriology, Army Dental School, Army Medical Center, Washington, D. C.

*Major (DC), U. S. Army.

†Captain (DC), U. S. Army.

‡Captain (DC), U. S. Army.

type Army physical examination. On the basis of clinical findings and salivary lactobacillus counts, one of us (W.E.L.) chose fifteen caries susceptible and fifteen insusceptible persons.

Salivary Counts.—The transient status of the patients permitted only one count. In each instance, paraffin stimulated saliva was collected approximately three to four hours after breakfast. The saliva was diluted 1:20 and 1:200 with sterile buffered physiologic sodium chloride solution pH 7.1, plated on tomato-agar pH 5.1, incubated anaerobically at 37°C. for seventy-two hours, after which the plates were examined and colonies estimated.

Serums.—These were obtained by centrifugation of from 3 to 5 cc. of blood after venipuncture following the dental examination. Each serum was immediately diluted 1:10 with a sterile saline solution and set up in the agglutination tests. In the tests, dilutions of serum ranged from 1:20 through 1:320.

Antigens.—Twelve strains of lactobacilli were chosen from our stock cultures as representative of the group. All stock strains were reexamined (N.B.W.) and lyophilized.[5] Antigens were obtained from the sealed vials containing the cultures by suspension in a sterile solution, plating on tomato-agar pH 6.1 and incubation anaerobically for forty-eight hours. The lactobacilli were suspended in a formalinized buffered saline solution, washed three times with saline solution (formalinized) and standardized by a nephelometer so that each cubic centimeter contained about 900,000,000 organisms.

Agglutination Reactions.—The results of the tests were read (V.H.D.) without knowledge of the category in which the patient had been placed. The degrees of agglutination were recorded by the conventional plus values. All tubes that contained a 2+ clumping or more were considered positive. All lower than 2+ were regarded as negative. The titers quoted throughout the paper are average titers computed from the highest titers

TABLE 1.—COMPOSITE CHART OF AGGLUTININ TITERS AMONG THE SUSCEPTIBLE

Strain	NVA*	Final Serum Dilutions 1/20	1/40	1/80	1/160	1/320
D-4-S	12	3†	2	1	0	0
D-7-A	3	12	6	1	0	0
D-7-S	7	8	6	5	1	0
D-9	8	7	4	1	0	0
D-11-B	1	14	13	8	3	0
D-12-C	6	9	8	2	1	0
D-14-B	8	7	1	0	0	0
D-17-B	13	2	0	0	0	0
D-28	2	13	8	5	1	0
29-2	13	2	1	0	0	0
30-1	9	6	6	5	2	0
30-2	3	12	12	6	1	0
	85	95	67	33	9	0

*No visible agglutination.

†Figures indicate the number of times a 2+ agglutination was observed with each strain out of a total of fifteen serums tested. All specimens were placed in a water bath at 50° C. and left for eighteen hours, and were then removed and chilled in the refrigerator for about four hours before reading.

TABLE 2.—COMPOSITE CHART OF AGGLUTININ TITERS AMONG THE INSUSCEPTIBLE

Strain	NVA*	Final Serum Dilutions 1/20	1/40	1/80	1/160	1/320
D-4-S	14	1*	0	0	0	0
D-7-A	4	11	5	4	0	0
D-7-S	6	9	5	3	1	0
D-9	7	8	1	0	0	0
D-11-B	0	15	13	10	3	1
D-12-C	3	12	7	5	2	1
D-14-B	10	5	1	0	0	0
D-17-B	14	1	0	0	0	0
D-28	0	15	12	6	1	0
29-2	12	3	1	0	0	0
30-1	2	13	12	6	1	0
30-2	2	13	12	9	4	0
	74	106	69	43	12	2

*See Table 1.

of each strain listed in Tables 1 and 2.

RESULTS

The data obtained from the agglutination tests with the serum from each individual have been combined and are presented in Tables 1 and 2. Study of these composite summaries of the thirty charts indicates that there is little difference in the total number of times that positive agglutination occurred. There is one exception, in strain 30-1, with which the insusceptible serums appeared to agglutinate more frequently in the lower dilutions. The two arbitrary categories seem to demonstrate similarity as to the number of strains agglutinated. Comparison of computed titers with all strains show that the susceptible ranged about 1:31 and the insusceptible 1:36. The highest titer for the susceptibles was 1:72, the lowest nil; while, for the insusceptible, 1:88 and 1:13 were found.

The salivary lactobacillus counts of each susceptible patient are compared with individual titers in Table 3. It is noted that, with very low titers, there are accompanying high counts; whereas, with comparatively high titers, the counts are negative. Great variation in the counts irrespective of increasingly higher titers is observed between these two extremes. The majority of the patients are found to be grouped between the titers of 1:14 and 1:34. Three persons presented high counts as compared with the others in the group. A different sort of pattern is observed in Table 4, wherein the same comparisons are made among the insusceptible. Relatively low counts are noted, regardless of titer, except in one instance, where a high count was found with a relatively high agglutinin titer (Patient 22D). Most of the individuals in the group were found to have a negative lactobacillus count. The fact that only one salivary count was made is a variable which, owing to the conditions of the study, could not be adequately controlled.

TABLE 3.—TOTAL SUSCEPTIBLE

Patient	Titer	Salivary Count
31R	nil	800,000
23T	1:2	234,000
3F	1:8	64,000
30F	1:14	8,000
2M	1:18	6,400
29D	1:20	200
9G	1:20	106,000
28T	1:24	42,000
15P	1:32	3,000
27B	1:32	46,000
18A	1:34	2,000
12C	1:34	3,600
10L	1:64	Negative
17B	1:65	Negative
25P	1:72	Negative

TABLE 4.—TOTAL INSUSCEPTIBLE

Patient	Titer	Salivary Count
14V	1:13	Negative
6A	1:15	Negative
19S	1:15	1,600
11E	1:15	7,000
24W	1:20	Negative
26W	1:25	4,500
8L	1:30	Negative
7J	1:37	Negative
21W	1:37	Negative
22D	1:40	74,000
1M	1:45	3,000
13P	1:47	Negative
16C	1:57	Negative
5C	1:60	Negative
20S	1:88	Negative

DISCUSSION

The small number of individuals and the number of uncontrollable factors in the salivary counts make it difficult to critically evaluate some of the subtler implications of this study. Secondly, because of the numerous variations in performing and interpreting agglutination procedures by different workers, no statistical significance can be attached to our titer values. Nevertheless, certain

results have significance in the study of lactobacilli as associated with the process of caries. The important feature is the nearly equivalent ratio (31:36) that exists between the two groups under comparison. The brief study of serologic phenomena demonstrated that the blood agglutinin titers for lactobacilli are not indisputable indicators of caries experience. It is also noted that the blood titer cannot be used as a sole indication of the degree in which lactobacilli inhabit the oral cavity. The variations observed among titer, salivary count and caries experience suggest that some abstruse factor is manifested which may or may not be associated with serum antibodies, or may not be detectable by the agglutination test. Inasmuch as salivary agglutinins for lactobacilli are reported as very low,[3, 6, 7] it is possible that this unknown factor might have been stimulated by the vaccination procedure used by Canby and Bernier.[3] They reported cases in which there was marked reduction in the lactobacillus count following vaccination, without a detectable rise in the blood agglutinin titer. It is also possible that such factors as were reported by Clough,[8] Hine,[9] Bibby[10] and Hill[11] might have been potentiated.

SUMMARY

1. In a comparison of the strength of the agglutinins for lactobacilli in the blood of fifteen highly caries susceptible and fifteen caries insusceptible patients, no significant differences could be demonstrated.

2. It seems that, without exception, the highest titers are accompanied by a negative salivary lactobacillus count irrespective of the caries experience. The low agglutinin titers in the two groups were not consistently accompanied by high salivary counts.

3. The high blood titers in our results appear to serve more directly as indicators of a low incidence of lactobacilli in the mouth rather than as an index of caries experience.

We acknowledge the technical assistance of T. Sergeant Gilbert O. Wright and Jessie H. Meredith, R.N.

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CONTINUOUS DEPOSITION OF CEMENTUM

BERNHARD GOTTLIEB,* D.D.S., Dallas, Texas

WE find no instance in nature wherein functioning teeth retain their form and maintain the same connection with the surrounding tissues throughout a lifetime. We see teeth worn down on the masticating surface on one side with a progressive loss of connection with the surrounding tissues on the other side. This means, in some instances, the danger of premature loss of the teeth.

There are some species in which loss of the masticating apparatus does not endanger the animal. Carnivorous animals can live without masticating ability. They can swallow a torn out piece of flesh and digest it. The herbivora must masticate properly in order to enable the intestines to make use of the food. The cellulose covering of the grass must be opened; otherwise the food content passes through the intestines without being used.

Correspondingly, we find quite different cementum conditions in carnivorous and in herbivorous animals. While the cementum in carnivorous animals is thin and limited to the root of the tooth, the herbivorous animal has thick cementum which extends over the enamel, making this part of the tooth useful also for functional purposes and for controlling the rate of eruption. Figure 10 illustrates the cementum on the enamel surface of an herbivorous animal.

Nature makes use of many different means to assure a prolonged function of the teeth. The simplest is the storing of a great many reserves to replace teeth which are to lose their functional ability.

We find this principle in the fishes and reptiles. There are differences in details, but the principle is the same. There is inside the jaw of the fish a place for manufacturing new teeth, protected by a plica. At roughly regular intervals, new teeth are released from this plica, passing the border of the curtain, while the teeth which functioned for a time on the crest of the alveolus are moved to the outside and released as useless. It reminds one of the action of an escalator. In Figure 1, we see an example of the arrangement of the teeth in fish. The teeth of reptiles are of a more complicated construction and are equipped with enamel. The tooth germs, embedded in the jaw, develop there and resorb the functioning tooth in eruption. The relationship is very similar to that of the permanent and deciduous teeth in the human being, the only difference being that the shedding continues at regular intervals throughout life in the case of the reptile, whereas it occurs only once in man. The reptiles change their teeth many times during life. The fish and the reptile never run out of reserves as far as the teeth are concerned. In Figure 2, we see the relative position of two sets of teeth in a reptile.

In the case of the reptile and the fish, we see a great similarity in the solution of the problem. However, when we study the mammals, we find a great variety, the principles even being different. The continuous growth of the tooth is very much alike in fishes and reptiles, but

*Professor of oral pathology, Baylor University College of Dentistry.

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the tooth is not replaced by a newly formed tooth. It has no substitute, and consequently must remain in place and do its work for a long time. The tooth is continuously erupting, and while the peripheral end is being worn down, new substance is built on the other end to replace the part worn away. Thus the tooth remains the same length and retains the same functional ability. The incisors of rats and all teeth of rabbits and guinea-pigs and of many other animals are of this kind. Figure 3 shows

Fig. 1.—Denture of fish. Protected by plica (a) the tooth germs 1, 2, 3 are in different stages of development. The tooth b is at the stage of falling out. Tooth c is at its functional height.

the molars of a rabbit. They are all continuously growing at the apical part and wearing down at the occlusal surface.

We find in the elephant's molars a different solution to the problem, a solution which is even more like that in the lower animals in spite of the fact that the elephant and the elephant's teeth are the

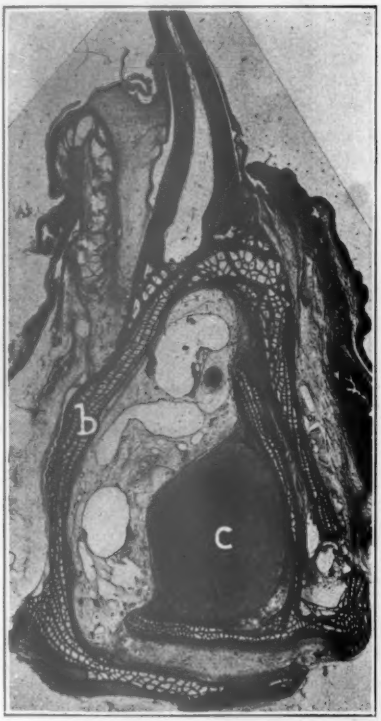

Fig. 2.—Tooth of reptile, showing ankylosis. b, alveolar bone. c, young tooth germ with its alveolar bone.

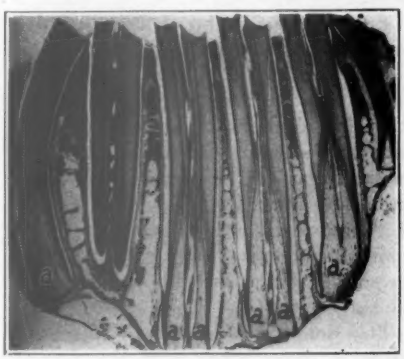

Fig. 3.—Molars of rabbit. The crowns are worn down. There is apposition of tooth substance at the open foramen (a).

Fig. 4.—Mandible of elephant. a, rest of worn-down molar. b, functioning part of following molar. c, non-erupted part of molar.

largest in the animal kingdom and their lifetime is the longest. There is always just about the equivalent of the occlusal plane of one molar in function. The mesioclusal corner of each molar erupts first and the tooth continues to erupt in that direction, while the surface is ground down more and more. Because of the grinding action, the occlusal surface becomes shorter mesiodistally and the tooth following erupts, replacing the lost surface.

In the lower jaw, the place of manufacture of the endless row of molars is in the ascending ramus of the mandible; while, in the upper jaw, this area is located in the maxillary tuber. New molars are prepared throughout life so that the elephant is always equipped with a masticating apparatus, no matter how long it lives. Figure 4 shows the lower jaw of an elephant. Only a part of the next molar is erupted and functioning. The distal part is still in the jaw, as is shown through a window in the bone.

This dental arrangement is quite different in many other mammals and in human beings. In the fishes, reptiles and elephants, the whole tooth is exchanged. In the continuously growing

Fig. 5.—Rat's molar. Hairs (b) penetrated the base of the crevice (a). The epithelium (c) grows around, separating and eliminating them.

teeth, such as are found in the rabbit, the whole tooth substance is worn down on the periphery and replaced at the growing center, and the individuality of the tooth is preserved throughout life.

The third method is a step forward in the direction of economy. Here, only new layers of cementum are continuously deposited, while the enamel and dentin remain the same.

Fig. 6.—Root surface of pig's tooth. a, epithelial attachment. b, new layer of cementum with cell in hole (e). c, non-calcified layer. d, older cementum with empty holes.

I have stated at the beginning that there are two ways for a tooth to lose its functional ability. These are the grinding down of the occlusal surface and the downward movement of the base of the crevice toward the apex (continuous passive tooth eruption). The grinding down of the occlusal surface is of minor importance in human beings.

Sometimes, we find dentures worn down to the level of the gum margin. It actually seldom happens and can be avoided easily. If we use our teeth only for the purpose of masticating food, which would consume about one-half an hour out of twenty-four hours, and if we keep the teeth apart the rest of the

Fig. 7.—Teeth of squirrel. There are pieces of non-calcified cementum (a) at the cemento-enamel junction.

time, not touching the lower with the upper teeth, we have taken care of that problem thoroughly. The other possibility is more important. The continuous passive eruption means a continuous elongation of the extra-alveolar lever unless there is a corresponding wearing down at the occlusal surface. We are often induced to grind down the elongated extra-alveolar lever in order to reduce the functional stress on the root.

The main problem in human and re-

lated teeth is the fight against the speed of continuous passive eruption. The shifting of the base of the crevice apically means a continuous shortening of the clinical root; that is, an impairing of the seat of the tooth. If this process continues with great speed, there is loosening and, finally, loss of the teeth.

The tooth represents a hole in the continuous epithelium blanket of the body. Whenever a foreign body pierces that epithelial blanket, the epithelium around the formed hole starts immediately to grow along the foreign body and to close the hole behind it. Thus, the foreign body is eliminated and the continuity of the epithelium cover is reestablished. In Figure 5, we see hairs in the connective tissue. These hairs originally were lost from the rat's fur and became mixed in the food and, during mastication, were forced through the epithelium at the base of the crevice in the connective tissue. The epithelium grows along the surface of these foreign bodies. It will engulf them and turn them out of the body.

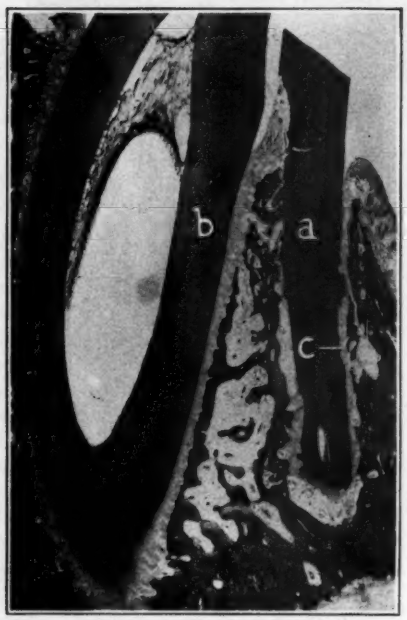

Fig. 8.—a, persistent deciduous cuspid of dog. b, permanent cuspid. c, resorption.

The part of the tooth outside the base of the crevice, the clinical crown, has a biologically dead surface, being in contact with the outside world and having no connection with tissue which is supplied with circulation. The belt of the tooth, which is in living connection with the epithelial attachment, is apparently the border between the living part of the tooth surface and the dead part. If the living part of the tooth surface inside the epithelial attachment becomes dead too, the epithelial attachment grows down, eliminating that part. It grows down until it meets a living part which cannot be overgrown by epithelium. A freshly deposited cementum layer, no matter how thin, means such a barrier to a further growth downward of the epithelium along the root surface and an impairment of the functional ability of the tooth.

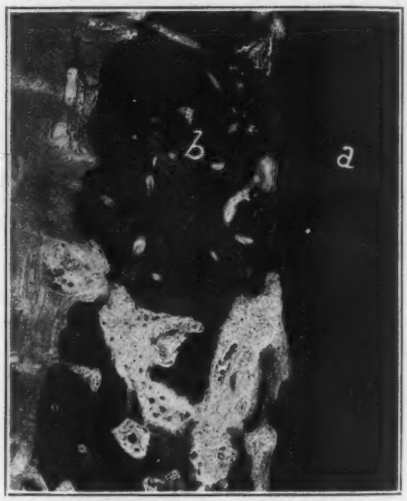

Fig. 9.—Higher magnification of ankylosis from Figure 8. a, tooth. b, bone.

Figure 6 shows the end of the epithelial attachment of a pig's tooth. Opposite the epithelium, we see a new layer

of cementum with an uncalcified surface apparently barring further downward growth of the epithelium along the tooth surface. Figure 7 shows analogous conditions in the squirrel. We find at the cemento-enamel junction large masses of uncalcified cementum apparently forming a barrier against downward growth of the epithelium.

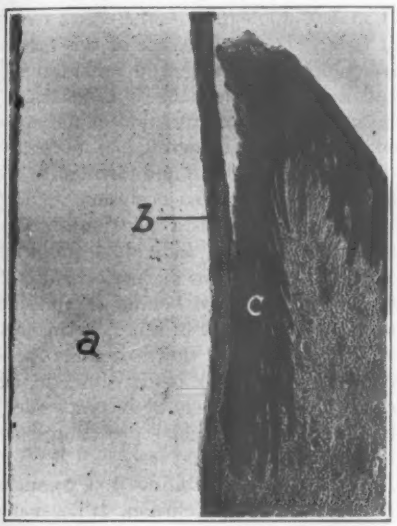

Fig. 10.—Tooth of herbivore. a, enamel lost by decalcification. b, cementum on enamel. c, epithelial attachment.

There is also another fact which makes the continuous deposition of new cementum layers imperative. In the continuous exchanging of the whole tooth or in the teeth with continuous growth at the apex, there is always a newly formed tooth surface in contact with the connective tissue. The root surface of human beings and similar mammals is supposed to remain in contact with the surrounding connective tissue to a considerable extent during life. Any hard tissue as it grows older may be resorbed earlier or later and may become ankylosed to the alveolar bone. In maintaining the protection of the tooth surface against resorption by the surrounding connective tissue, and in safeguarding the tooth, as a separate organ, from being fused to the neighboring bone, a newly formed coat of cementum seems to serve best.

Figure 8 shows a persistent deciduous cuspid on the side of the permanent cuspid. The surface of the persistent tooth shows many areas of resorption and, at one place, an ankylosis, while the permanent tooth shows a perfectly smooth root surface.

Figure 9 shows the ankylosed part of the persistent deciduous tooth in a higher magnification.

In herbivorous animals, Nature must take care that there is especially good function of the teeth, because the teeth are vital organs in these animals. Figure 10 shows how cementum is deposited on the surface of the enamel, and thus that part of the tooth is fitted for functional purposes.

HABITS AND THEIR RELATION TO MALOCCLUSION

LELAND R. JOHNSON, D.D.S., M.S.D., Chicago, Ill.

THE field of habits as related to malocclusion is so large that any attempt to confine it to a single paper requires a very general discussion. It is commonly conceded that, in the diagnosis and treatment of malocclusion, any habit associated with malocclusion must be considered from the viewpoints of etiology and therapy.

Habit, as the dentist usually thinks of it, is the frequently repeated application of force to the denture from outside or from sources closely associated with the denture. However, this is not always true. Many times, a habit that may directly affect the occlusion is a habit of omission. Failure of any force which is normally utilized to assure a normal denture will unbalance the normal forces of occlusion to the extent that malocclusion may occur. Therefore, we are as vitally concerned with the normal functioning of the musculature directly associated with the denture as we are with those introduced forces which bring abnormal pressure to bear on the denture.

The etiology of any given case of malocclusion may have been a combination of numerous factors of which one factor may have been some habit. Usually, the habit is an associated etiologic factor, although occasionally one might be safe in stating that a particular case of malocclusion was caused by a definite habit. At any rate, it can definitely be said that habit as an etiologic factor in malocclusion is very potent, and some of the worst complications of some cases of malocclusion may be the direct result of habit. The significance of this fact is recognized by experienced practitioners, and every possible habit is carefully investigated. Normal function of the musculature is also recognized as necessary to balanced occlusion and essential to retention of a corrected occlusion.

Whenever habit is a contributing factor, therapy is an individual problem. There is variation in the performance of the habit, the urge behind it and the therapy. With that in mind, it becomes impossible to lay down definite procedures which will be effective in all cases. Procedures may be recommended, but, very often, special procedures are required for individual cases.

The habit of lip-biting is a common contributor to malocclusion. It has many variations. Either lip may be bitten and in many different ways. Often, the action is so rapid that its detection is difficult. Frequently the lip is held between the teeth with varying degrees of pressure in different cases. In some lip-biters, the upper lip is fairly well developed, in others, not. If the upper lip is bitten, the maxillary incisors in all probability will be tipped lingually. If the lower lip is bitten or held between the teeth, the maxillary incisors will probably be tipped labially. If the left and right sides of the lower lip are bitten alternately, rotation of the maxillary central incisors will result.

The type of lip habit most frequently seen consists of four distinct steps blended into one smooth action. 1. The tongue moves forward and wets the lower lip. 2. The lower lip is turned inward. 3. As

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the tongue returns to the mouth, the lower lip is grasped between the teeth. 4. As the lower lip returns to its original position, gentle pressure is applied to the maxillary incisors and they are tipped labially. The amount of the protrusion depends upon the thickness of the lower lip, which maintains the deformity.

Lip-biting is frequently associated with other habits, such as tongue-thrusting and abnormal swallowing, and becomes only one phase of a complete action. Correction of the lip-biting habit is more successful if the protrusion is first reduced.

The successful treatment of habit is based upon motivation of the patient. Unless the patient really desires to break the habit, success is remote. Motivation is entirely an individual problem, and the ability of the operator to analyze the child's personality and strike the chord that will bring response is the key to success. All other procedures aimed at the correction of the habit are secondary and are presented to the patient only as aids in reaching the goal that he has established. This applies to all habit therapies. Definite personalities are developed in children by the end of the second year and each personality requires its own separate approach.

To aid the patient in breaking the lip-biting habit, pomade lipstick may be used. The grease on the lip reminds the patient not to bite the lip. The pomade also relieves the chapped condition of the lip, which may be the basis of the urge to bite the lips.

Tongue habits produce definite types of malocclusion, and are probably the most troublesome habits of all. Tongue-thrusting is frequently associated with lip-biting, and when the tongue is thrust forward, a malocclusion similar to that from lip-biting results. Tongue habits may affect any part of either arch. Side thrusts may affect the lateral segments. Frequently, the tongue is forced between the maxillary central incisors; which maintains and widens the space between them. Open-bite malocclusion, which it is so difficult to treat successfully, is often caused by a tongue habit. The tongue may lie between the maxillary and mandibular teeth and the teeth thus be prevented from erupting. This region may include only the incisor area, but frequently extends back as far as the first permanent molars. Every time the patient swallows, the tongue is forced between the teeth and a great deal of pressure results. Successful treatment and retention of this type of malocclusion depends on the elimination of the tongue habit. Speech defects usually accompany these habits and are contributing factors in the malocclusion.

Treatment of the tongue habits consists in teaching the patient to swallow normally. This is difficult and one is apt to become discouraged before the habit is corrected. A small piece of candy is placed upon the palate just back of the central incisors, and the patient is taught how to hold it there with the tip of the tongue. As the candy dissolves, the tongue is held in this position while swallowing occurs. It is very important that the candy be well forward or it will be held in the palate by the dorsum of the tongue, the tip of the tongue being left free to operate as always and the purpose of the exercise being defeated. As the patient learns the corrected tongue position, use of the candy may be discontinued, the patient being instructed to place the tongue in that position at each act of swallowing. The services of a good speech teacher should be secured to correct the speech defects.

Sucking habits are quite common and are not confined to the thumbs or fingers. The cheeks may be sucked in and held between the biscuspids and molars, a combination of cheek-sucking and cheek-biting. This habit may result in an open bite on each side or it may simply narrow the arches by tipping the bicuspids and molars lingually.

Lip-sucking is not uncommon and, as in lip-biting, the malocclusion will vary according to which lip is sucked. The degree of tipping of the incisors also will depend on the nature of the act and may vary from simple tipping, as in lip-biting, to bodily movement, as in some cases of thumb-sucking. When the upper lip is sucked, the maxillary incisors usually become locked lingually to the mandibular incisors. When the lower lip is sucked, the maxillary incisors are usually tipped labially and the mandibular incisors may be tipped lingually.

Treatment of these habits is the same as for lip-biting. It is quite important that this habit be treated early.

It is generally agreed among orthodontists that thumb sucking may be an etiologic factor in malocclusion. Among children with malocclusion, the incidence of thumb-sucking or finger-sucking is 17.49 per cent. It cannot be said that all of these cases are caused by thumb-sucking or finger-sucking. At some time during development of the malocclusion, thumb-sucking or finger-sucking persisted. It has been said that if the thumb-sucking habit is broken by the end of the fifth year, the malocclusion will have a tendency to correct itself. This statement is dangerous and misleading. The only cases that can possibly correct themselves if the habit is not corrected until the end of the fifth year are those in which there are normal function of the lips and a normal relationship of the jaws. Again, if a normal relationship of the jaws exists, but a normal relationship of the lips does not, in all probability the malocclusion will persist. If a normal relationship of the jaws does not exist, there is very little likelihood of any correction. Forty per cent of thumb-suckers continue the habit after the end of the third year and 10 per cent continue the habit for more than ten years. With these figures in mind, it would seem advisable to correct thumb-sucking and finger-sucking habits early.

The habit results in two types of malocclusion, depending on the position of the hand in sucking the thumb. If the hand is held high, the jaw relation remains normal and a labial tipping of the maxillary incisors occurs. If the hand is permitted to drop, a prying force is exerted. The back of the thumb rests on the mandibular incisors and the palmar surface creates a labial pressure on the maxillary incisors and the alveolar process. In this instance, the process as well as the teeth is moved forward. Occasionally, an open-bite malocclusion results from thumb-sucking.

Thumb-sucking is often accompanied by accessory habits such as pulling the hair or scratching the skin, even to the extent of causing pain. There are many variations of this practice. Other habits that may be associated and may modify or accentuate the malocclusion are mouth-breathing, open-mouth, lip-biting, lip-sucking, tongue-sucking, cheek-sucking, tongue-thrusting, etc.

Treatment of the habit requires motivation. It is also desirable to determine, if possible, the reason behind the habit. When the habit is in the early stages, there seems to be little emotional excitement. After the habit has progressed to the point that it becomes a substitute activity in situations that arouse emotional stress, the provision and stimulation of more desirable activities become more important than the habit itself. This method is ideal, but often other methods paying special attention to the habit itself may be necessary.

Many methods are described in the literature, ranging from the use of bitter tasting drugs, which are painted on the thumb or finger, to the employment of appliances on the arm to prevent reaching the mouth with the thumb. The undesirable feature of the appliance on the hand or arm is that it may attract attention to the arm or hand, which is already associated with the response, and thereby aggravate the habit instead of aiding

in its elimination. Again, it is an individual problem. For those children who suck the thumb only when going to sleep, the wearing of boxing gloves has been very successful. Freedom of movement is permitted, the thumb is too large to get in the mouth and it is impossible for the patient to remove them. It is important to make the child believe that wearing the boxing gloves will help him to break the habit and all children wish to break it.

Prevention of the habit before it has become established is much better than breaking it later. Care must be exercised not to call attention to the habit itself, but to substitute activities that keep the interest in wholesome channels.

An appliance to break the thumb-sucking habit which has proved very efficient is worn in the mouth. The maxillary first deciduous molars are banded and to the bands is soldered a wire which crosses the palate and stands far enough away from the palate to prevent suction between the thumb and palate. By converting a pleasant situation into an unpleasant one, the habit may be broken.

Mouth-breathing is a common habit, but all patients who hold the mouth open are not mouth-breathers. Many breathe entirely through the mouth. Some hold the mouth open and breathe through both the nose and the mouth. Others hold the mouth open and breathe through the nose. Tests must be made in order to classify the habit. Mouth-breathing is usually caused by adenoid tissue or some nasal obstruction. Consequently, the typical adenoid facies frequently accompanies this condition.

It was once thought that children having a Class II, Division 1, malocclusion were mouth-breathers. This is not necessarily true, nor is it true that all mouth-breathers have a Class II, Division 1, malocclusion. Any type of malocclusion may accompany mouth-breathing. The classical type of malocclusion often found among mouth-breathers is associated with a narrowing of the maxillary arch and possibly of the mandibular arch, protrusion of the maxillary incisors, supraversion of the mandibular incisors, a lack of vertical development in the bicuspid and molar areas and distal relationships of the mandible to the maxillae. With this type of malocclusion, there is a short, underdeveloped upper lip, a lower lip that is thickened and rolled outward, underdeveloped nostrils, lack of tone of the facial musculature and a vacant stare.

Treatment of this habit requires removal of any nasal obstruction and breaking of the mouth-breathing habit as soon as orthodontic treatment has progressed far enough to reduce the protrusion of the incisors so that the lips can be closed without too much effort. Most of the patients use the lower lip almost entirely in closing the lips, and this results in the overdevelopment of the mentalis muscle, which is very troublesome and must be overcome to assure the success of treatment. In instructing the patient in exercises to teach normal breathing, it is essential that the mentalis muscle be controlled. To accomplish this, the patient grasps the chin between the thumb and forefinger and holds the lower lip down, while the upper lip is forced to come down to meet the lower when the lips are closed. This should be done several times, three or four times daily. To augment the effect, the patient should be taught to whistle. Whistling not only causes the mentalis to function as desired, but also develops the orbicularis oris and the associated muscles and the muscles controlling the alae nasi. For correction of the mouth breathing, a small celluloid paddle may be held lightly between the lips while the child is reading or studying.

Propping and pillowing habits, which consist in pressure applied by the hand or fist to the outside of the face, affect the teeth in the area where pressure is applied. The pillowing habit is usually found among sleepers who sleep on the

stomach and use the hands for a pillow. This habit frequently causes crossbite malocclusion.

To treat the pillowing habit, two rows of golf balls are sewed in the front of the pajamas. The discomfort will cause the patient to sleep in other positions.

One statement that should again be made because of its extreme importance is that motivation of the patient is absolutely essential to success. Arouse the desire of the child to break the habit and the battle is half won.

180 North Michigan Avenue.

BASE METAL ALLOYS FOR ORAL RESTORATIONS

GEORGE C. PAFFENBARGER,* D.D.S.; H. J. CAUL,* B.S., and GEORGE DICKSON,† M.A., Washington, D. C.

INTRODUCTION

THE substitution of base for noble metals and alloys has long been one of the romantic problems in science. Special emphasis has been given to this search in the last two decades because many countries have had a reduced gold supply during this period. In dentistry, many types of base metal alloys have been tried as substitutes for gold alloys, not only in the larger appliances, such as those used in prosthesis and orthodontia, but even in small fillings. Various types of these base metal alloys are here considered.

It should be noted, however, that since the cost of the metal is such a small part of the total cost of the dental restoration, the cost alone has never justified the substitution of a base metal where a noble metal would give more satisfactory service. If the base metal alloys are to be used at all, they must produce restorations that are equal to those made with noble metals. At the present time, the base metal alloys must show a definite superiority or an important saving in cost to justify their use where non-strategic noble metals have proved satisfactory.

COPPER BASE ALLOYS

Alloys having a copper base have been tried not only in foreign countries, but also in the United States. Such alloys have not been found suitable for dental service. Copper-zinc alloys sold under such trade names as Chromgold, Platinoid and Edelbronze, which were frequently employed in Central Europe, discolored and corroded badly. The copper salts formed by the action of the mouth environment caused local irritation of the soft tissues adjacent to the restorations. Otto Preissecker, of Vienna,[1] reported that, in many instances, systemic poisoning occurred. As a result, several countries passed laws prohibiting the use of copper base alloys in oral restorations.

In 1931, the National Bureau of Standards and the American Dental Association Research Commission investigated an aluminum bronze sold under the trade name Postizo Gold.[2] An analy-

*Research Associate of the American Dental Association at the National Bureau of Standards.

†Assistant physicist, National Bureau of Standards.

*Publication authorized by the Executive Board of the Research Commission of the American Dental Association.

sis of this alloy revealed the following composition: copper, 86.9 per cent; aluminum, 9.8 per cent; tin, 2.0 per cent, and nickel, 1.3 per cent. After its exposure, this imitation gold alloy soon disappeared from the market, only to reappear under a different name in 1943 with a slight reduction in the amount of tin.

TABLE 1.—COMPARISON OF MECHANICAL PROPERTIES OF 18-8 STAINLESS STEEL AND WROUGHT GOLD ALLOY WIRE

Hardness	Ultimate Tensile Strength	Yield Strength	Modulus of Elasticity	Modulus of Resiliency	Elongation
Brinell Number	Lb./In.²	Lb./In.²	Lb./In.²	Lb./In.³	Percentage in 2 Inches
18-8 Stainless Steel (Wrought)*					
Softened, 1038 to 1204°C. (1900 to 2200°F.), quench					
145 to 160	85,000 to 95,000	30,000 to 35,000	29,000,000	16 to 21	55 to 60
Hardened, only by cold working					
170 to 460	105,000 to 300,000	60,000 to 250,000	29,000,000	60 to 1100	2 to 50†
Gold Alloys (Wrought)‡					
Softened, 700°C. (1292°F.) for 10 minutes, quench.					
Vickers Number 200 to 250	85,000 to 130,000	65,000 to 90,000	12,000,000 to 15,000,000	180 to 280	15 to 20
Hardened, softened as above, then cooled from 450 to 250°C. (842 to 482°F.) in thirty minutes, quench.					
270 to 365	130,000 to 185,000	90,000 to 140,000	13,000,000 to 16,000,000	430 to 680	2 to 10

*These data were obtained largely from Metals Handbook (1939 edition), American Society for Metals and the Book of Stainless Steels, edited by E. E. Thum, American Society for Metals, Cleveland, Ohio (1935), and from references given in these two publications. The ranges of values are representative and are not all-inclusive.

†Gage length, 10 inches.

‡Data from J. A. D. A., 19: 2061, December 1932. The range of values is representative and is not all-inclusive.

TIN BASE ALLOYS

Tin base alloys have not been found satisfactory for use in prosthetic appliances. Tin-antimony alloys have been used in inlays and bridges of heavy construction with little success. One such alloy is now made and used in America under the name Acolite, which, according to an analysis made by the late Aaron Isaacs, associate chemist at the National Bureau of Standards, consists of tin, 72.5 per cent, and antimony, 27.5 per cent. Its hardness is near that of pure gold as cast. The alloy is brittle and discolors.

Alloys of tin, bismuth and gallium

have been used in Germany. Wiga was the trade name of one of the more popular alloys of this type. Several years ago, an attempt was made to market Wiga in this country. Fortunately, the importer submitted the alloy to the A.D.A. Research Fellowship at the National Bureau of Standards for its advice. The alloy had a melting point so low that it could be introduced into the cavity in a molten state.[3] Besides possible poisoning from the gallium present, one can readily see that the extremely low melting point would preclude the use of the alloy in the mouth. These characteristics were brought to the attention of the importer, who decided against marketing the alloy in this country.

TABLE 2.—BASE METAL CASTING ALLOYS INVESTIGATED

Trade Brand Name	Firm	Address
Lunorium	Salabes Research Laboratories, Inc.	Baltimore, Md.
Niranium	Kromel Laboratories	New York, N. Y.
Ticonium	Ticonium	Albany, N. Y.
Vitallium	Austenal Laboratories, Inc.	New York, N. Y.

SILVER BASE ALLOYS

Alloys of silver-copper, silver-tin, silver-platinum and silver-palladium have all been tried, either as binary alloys or modified with gold and copper. The modified silver-palladium alloys are perhaps the most nearly satisfactory of this group, for replacement of gold alloys.

Almost twenty years ago, an alloy containing 60 per cent silver and 40 per cent palladium was used in this country for swaged denture bases.[4] In England, even prior to that time, alloys of silver-platinum and silver-palladium were extensively used.[5] In Germany, under the stimulus of the *ersatz* program, a considerable amount of investigative work was done on modifications of the silver-palladium alloys.[6]

TABLE 4.—"FREEZING TEMPERATURES" OF BASE METAL CASTING ALLOYS

Alloy	Freezing Temperature*	
	C.	F.
Lunorium	1362	2484
Niranium	1300	2372
Ticonium	1290	2354
Vitallium	1395	2543

*Each of these alloys solidified over a range of temperature of a few degrees centigrade. The values given in the table are the mean values of these ranges of temperature.

TABLE 3.—CHEMICAL COMPOSITION OF BASE METAL CASTING ALLOYS (PERCENTAGE BY WEIGHT)

Alloy	Chromium	Cobalt	Nickel	Molybdenum	Tungsten	Iron	Manganese	Silicon	Carbon	Aluminum	Beryllium	Total
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Lunorium	14.9	0.9	55.6	18.5	4.0	5.0	0.2	0.4	0.2			99.7
Niranium	28.8	64.2	4.3		2.0			0.1	0.2	0.7		100.3
Ticonium	27.4	28.7	37.5	4.6				0.2	0.2	0.2	1.2	100.0
Vitallium	30.8	62.5		5.1		0.7	0.5	0.3	0.4			100.3

According to personal testimony (to one of the authors, G.C.P.) by many research workers, teachers and dentists in Central Europe, these alloys would not have displaced gold base alloys had it not been for various governmental decrees prohibiting or severely restricting the use of gold in dental restorations. Alloys with the silver-palladium base were difficult to cast, did not have a high resistance to tarnish and were used only because better alloys were not available.

None of the silver-tin alloys have been found satisfactory for dental castings, but they are used extensively in dental amalgam. According to Preissecker,[1] silver-tin alloys containing less than 19 per cent or more than 90 per cent tin are too soft for dental use. The remaining alloys of the silver-tin system are brittle because of the presence of the compound Ag_3Sn. Preissecker also states that the silver-rich tin alloys are not satisfactory in the mouth.

TABLE 5.—KNOOP HARDNESS NUMBERS OF BASE METAL CASTING ALLOYS

Alloy	"As Cast" Kg./Mm.²	Softest* Kg./Mm.²	Hardest* Kg./Mm.²	Increase Softest to Hardest Condition Per Cent
Lunorium	274	265 1200°C. (2192°F.)†	302 600°C. (1112°F.)	14
Niranium	344	332 1200°C. (2192°F.)†	418 950°C. (1742°F.)	26
Ticonium	336	277 1200°C. (2192°F.)†	378 800°C. (1472°F.)	36
Vitallium	388	390 1200°C. (2192°F.)†	449 900°C. (1652°F.)	15

*Specimens were held one-half hour at the temperatures indicated and then quenched.

†All of the alloys were discolored very much at this temperature, and the surfaces were somewhat roughened. The ticonium and niranium specimens were warped.

IRON BASE ALLOYS

Wrought alloys, the main constituent of which is iron, modified chiefly by chromium and nickel, are commonly known as stainless steels. These alloys have had and are having a widespread use in orthodontics and prosthetics. Even in the United States, where there is certainly no gold shortage, this is true. Many orthodontists regard the stainless steels as superior to precious metal alloys especially in resistance to discoloration.

It appears that Friedrich Hauptmeyer, chief of the Krupp Dental Clinic in Essen, Germany, was the first to utilize stainless steel for oral appliances.[7]

The austenitic steels of the 18 per cent chromium, 8 per cent nickel type have in general been found the most suitable of the stainless steels for the construction of oral appliances. They are commonly referred to as the 18-8 type. According to Scharschu,[8] the range of composition of commercial American alloys of this type includes: carbon, under 0.20 per cent; manganese, under 0.50 per cent; chromium, from 17 to 20 per cent; nickel, from 7 to 10 per cent, with the remainder iron. To prevent intergranular corrosion, small amounts of other elements such as titanium or columbium are usually added.

The physical properties of 18-8 stainless steels vary over a considerable range, depending on their composition, and the thermal or mechanical treatments to which they have been subjected. Comparable data on 18-8

stainless steel and wrought gold alloy wires in Table 1 demonstrate that, from a mechanical standpoint, the two types of alloys are suitable for the same dental purposes if the respective wires are used in the proper condition. One definite advantage of gold alloy wires is that they can be softened and adapted easily to the proper shape and can then be hardened by an appropriate heat treatment, while stainless steel wires, if once softening by heating, cannot be hardened except by cold working, which is often impractical in the fabrication of dental appliances. Stainless steel is extremely tough in the cold worked condition as it has high strength and elongation. Furthermore, it has a large reduction of area at the point of fracture. It is this combination of high values for strength, elongation and reduction of area that makes 18-8 the superb alloy for tie wire in orthodontics and in the reduction of maxillary fractures. Ingenious methods of fabricating appliances of stainless steel, without resorting to soldering and without removing the work hardening, have contributed to make it a valuable dental material.

TABLE 6.—TENSILE PROPERTIES OF BASE METAL CASTING ALLOYS

Alloy and Treatment*	Ultimate Tensile Strength Lb./In.²	Yield Strength Lb./In.²	Elongation Per Cent
Vitallium			
As cast, mfr.	97,000	58,000	4.1
1000°C., mfr.	101,000	52,000	3.1
As cast, N.B.S.	94,000	47,000	1.0
Ticonium			
As cast, mfr.	73,000	47,000	0.8
1093°C., mfr.	77,000	33,000	2.0
1000°C., N.B.S.	80,000	43,000	1.4
1000°C., 700°C.†, N.B.S.	90,000	56,000	1.2
1093C., 703°C.‡, mfr.	90,000	74,000	1.2
Niranium			
1000°C., N.B.S.	82,000	43,000	0.7
700°C., N.B.S.	85,000	47,000	1.3
Lunorium			
As cast, N.B.S.	69,000	32,000	1.4
Federal Specification QQ-G-540 and Amendment 1 Minimum Values for Type IV Gold			
Softened	—	—	10
Hardened	90,000	65,000	2

*Specimens were heated in an oven one-half hour (unless otherwise noted) at temperatures indicated and then quenched. Specimens marked mfr. were cast by the manufacturer; those marked N.B.S. were cast at the National Bureau of Standards.

†Quenched from 1000°C., then reheated and quenched from 700°C.

‡In oven one-quarter hour at 703°C. before second quenching.

The modulus of resiliency (an index of the work that the material will do when used as a spring) of cold worked stainless steels compares very favorably with that of gold alloy wires. Clinical use in orthodontics has shown 18-8 stainless steel to be strong enough as a spring to do the necessary work.

Appliances of cast stainless steels are unsatisfactory because of inferior physical properties. The use of stainless steels in dentistry has therefore been almost entirely restricted to material in the wrought state.

COBALT-CHROMIUM BASE ALLOYS

Many alloys of base metals have been cast into dental appliances, but only certain corrosion-resisting alloys containing chromium have been satisfactory. In general, these alloys belong to, or are modifications of, the stellite class of alloys, which contain, primarily, cobalt, chromium and tungsten (or molybdenum). The stellite alloys were perfected by Elwood Haynes, pioneer automobile manufacturer, who obtained a patent in 1907 on cobalt-chromium alloys. Later, he added tungsten and molybdenum to produce the stellites, which combine hardness, strength, per-

manence of finish and resistance to abrasion, to an extent probably greater than in any other class of alloys.[9] In dentistry, stellites have been used for years for instruments wherein these properties were desired. However, it was not until 1929, when R. W. Erdle and C. H. Prange of the Austenal Laboratories developed a technic and materials for casting a cobalt-chromium-tungsten alloy (to which they gave the trade name vitallium) into dental appliances, that this type of alloy was successfully used for oral restorations. Since then, numerous alloys of this and related types have been used.

and cobalt, which makes the alloys brittle and unfit for technical purposes. The alloys listed in Table 3 have chromium contents of less than 32 per cent. These authors [10] showed that the physical and chemical properties of the alloy containing 70 per cent cobalt and 30 per cent chromium are superior to those of other combinations on either side, such as alloys containing 80 per cent cobalt and 20 per cent chromium or 60 per cent cobalt and 40 per cent chromium. The ratio between the cobalt plus nickel content and the chromium content of niranium, ticonium and vitallium approximates 70 to 30.

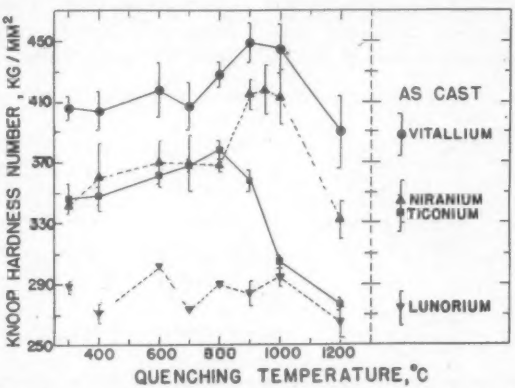

Fig. 1.—Knoop hardness numbers of base metal casting alloys when quenched from temperatures of 300 to 1200°C. and as cast (no heat treatment).

NEW DATA ON FOUR COBALT-CHROMIUM ALLOYS

Four cobalt-chromium base alloys have been investigated and the data are reported below. These alloys and the firms which sell them are listed alphabetically in Table 2.

Composition.—The composition of the alloys is given in Table 3. Chromium, a major constituent of all the alloys, renders them passive. Wever and Haschimoto, in their monumental work on the cobalt-chromium alloys,[10] show that increasing the chromium content beyond 32 per cent results in the formation of intermetallic compounds of chromium

In all of the alloys but vitallium, nickel has been substituted in varying amount for cobalt. The less expensive nickel can be substituted for part of the cobalt because of the similar, but not identical properties of the two metals. The qualities of the cobalt-chromium alloys can be improved by the addition of molybdenum or tungsten, which accounts for their presence in the dental alloys (Table 3).

Carbon, a minor constituent in all of the alloys, has, in the range of its solubility, a favorable influence upon the mechanical properties of the cobalt-chromium alloys without decreasing ap-

preciably the resistance to corrosion. The solubility of carbon in the alloy 70 per cent cobalt, 30 per cent chromium, is about 0.2 per cent.[10] Wever and Haschimoto, in investigating the influence of other elements upon the properties of cobalt-chromium alloys, found that, in the majority of instances, impurities caused an impairment of the mechanical and chemical properties of the alloys.[10] Among the injurious elements which these workers cited are iron, manganese, silicon and especially aluminum. It seems, if their work is reliable, that these elements should be eliminated as nearly as possible.

The four alloys in Table 3 are thought to be similar to alloys produced commercially for purposes other than dental.

42.4 per cent, chromium 26.5 per cent, nickel 26.4 per cent, silicon 1.6 per cent and aluminum 1.6 per cent. The composition given in Table 3 and the data on niranium herein reported are on material of recent purchase.

Freezing Temperature.—The melting ranges of the alloys were not determined. Instead, the following procedure was carried out by W. F. Roeser, of the Pyrometry Section of the National Bureau of Standards: 1. Each alloy was heated *in vacuo* in a beryllium oxide crucible. 2. Cooling curves were run throughout the range of 1450 to 1150°C. (2642 to 2102°F). 3. The mean of the observations taken during the period of freezing, a narrow range of a few degrees for each of the alloys, was deter-

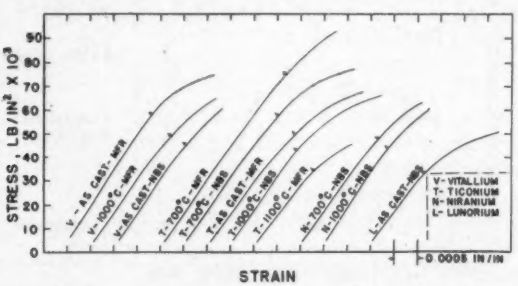

Fig. 2.—Representative stress strain curves of base metal casting alloys. The notation on each curve indicates the temperature at which the specimen was quenched and by whom it was cast. The arrows indicate the yield strength.

Lunorium appears to be very similar to Hastelloy C, the reported partial composition of which in percentage by weight is chromium 14, nickel 58, molybdenum 17 and tungsten 5.0.[11] Ticonium is essentially one of Borscher's alloys (reported composition in percentage by weight, chromium 30, cobalt 35, nickel 35 and molybdenum 0.5 to 5[12]) modified with beryllium. Niranium and vitallium are essentially stellite alloys or slight modifications thereof. The composition of niranium was drastically changed during the course of this investigation. Its former composition had been partially determined and was found to be cobalt

mined. The results are given in Table 4.

The higher melting points of these alloys necessitate the use of special technics. For handling base metal alloys, special investments made to withstand high temperatures, torches capable of giving hotter flames than are necessary for melting gold alloys and larger casting machines than those usually employed for gold alloys must be used.

Hardness.—The indentation hardnesses of the four alloys were determined with an instrument (previously described[13]) employing a Knoop indenter.[14] The specimens were disks of the cast alloys approximately 12 mm. in diameter and

2 mm. thick. A load of 1 kg. was applied for twenty seconds. The hardness of each disk was first determined in the "as cast" condition. Individual specimens were then heated for thirty minutes at temperatures ranging from 300 to 1200°C. (572 to 2192°F.) and quenched in water at room temperature. The average values of ten or more indentations on each of two specimens in the "as cast" condition and for specimens in the softest and hardest conditions are given in Table 5, together with the temperatures at which these conditions were obtained. In the "as cast" softest and hardest conditions, the alloys generally ranked from the softest to the hardest: lunorium, ticonium, niranium, and vitallium. The effect of the heat treatments, calculated as the percentage increase in hardness number from the softest to the hardest condition, is given in the last column of Table 5. The increase in hardness of lunorium and vitallium was markedly less than that of niranium and ticonium. We were unable to correlate the response of the alloys to heat treatment with their composition (Table 3). A graph showing the relationship between the hardness values and the temperature from which the alloys were quenched is given in Figure 1. The deviation of observed results from each average value is indicated by the length of the vertical line passing through each point. Heating the alloys for five hours, instead of for thirty minutes, at the temperatures at which maximum hardening occurred generally softened the alloys slightly.

As is usually the case, there was a definite relationship between the hardness of the alloys and some tensile properties. This is subsequently demonstrated.

Tensile Properties.—The yield strength, tensile strength and elongation were determined on specimens from 4.5 to 6 inches long and from 0.075 to 0.095 inches in diameter. Specimens of all four alloys were cast in the dental research laboratory of the National Bureau of Standards, with the materials and technics that were recommended by the manufacturers. There was one exception in that we were unable to cast satisfactory rods of niranium in the investment supplied with that alloy. Consequently, the test rods of niranium were cast into the investment supplied for use with vitallium.

In addition, each manufacturer was invited to provide test rods cast in his

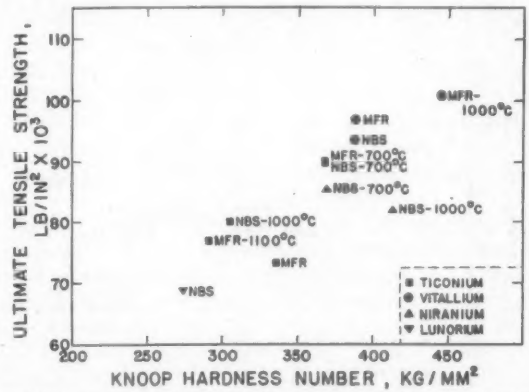

Fig. 3.—Relationship between ultimate tensile strength and Knoop hardness number. The notation at each point indicates the temperature from which heat treated specimens were quenched and by whom the specimens were cast.

laboratory. The manufacturers of vitallium and ticonium furnished excellent specimens. The specimens cast of niranium by the Kromel Laboratories were short, thick and of irregular diameter and could not be used. No specimens of lunorium were received from the manufacturer. Hence, all of the data herein reported on niranium and lunorium were obtained on specimens cast at the Bureau's laboratory. Data on the tensile properties of vitallium and ticonium obtained from specimens made by the manufacturer are reported separately from those obtained on specimens made by the Bureau workers.

Loads were applied by a hydraulically operated testing machine which was adjusted to give loads of 0 to 1,000 pounds. The strain was measured with two Tuckerman optical strain gages (1-inch gage length).

The yield strength is an indication of the minimum stress required to deform an appliance to such an extent that it will not return to its original shape when the stress is removed. It is also an index of the minimum stress required to adjust and adapt an appliance. In this report, the yield strength is defined as the stress (load per unit cross-sectional area) at which the strain (increase in length per unit length) produced by an increment of stress equals or exceeds 1.25 times the average strain produced by the first increments of stress. An initial load of 10 or 20 pounds was applied. This was sufficient to hold the specimen straight while the strain gages were mounted and adjusted. The load was then increased by 10-pound increments until the strain for the last increment far exceeded that of the first few loads. Typical stress-strain curves of the four alloys are given in Figure 2.

The slope of the straight part of all of these stress-strain curves is about the same, which means that the stress-strain ratios, that is the moduli of elasticity of all the alloys, are practically the same. The values fall within the range 26,000,000 to 31,000,000 pounds per square inch. As the modulus of elasticity is a measure of the stiffness of the alloy, it follows that all of the alloys, regardless of the treatment that they received, have about the same degree of stiffness.

Data on the tensile properties are given in Table 6. The values for yield strength vary from about 30,000 to 75,900 pounds per square inch as shown in Figure 2 and Table 6. Ticonium and vitallium

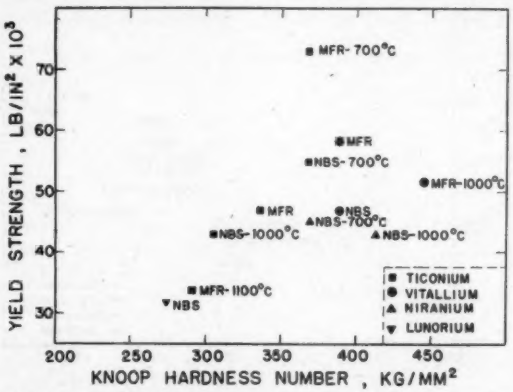

Fig. 4.—Relationship between yield strength and Knoop hardness number. The notation at each point indicates the temperature from which heat treated specimens were quenched and by whom the specimens were cast.

specimens had higher yield strength than did niranium and lunorium. It seems that the yield strength of ticonium was increased when specimens, after being quenched from 1000 or 1093°C., were reheated to 700°C. and quenched.

The values obtained for ultimate tensile strength, which is the stress causing rupture of the specimen in tension, are also given in Table 6. These values for the four alloys vary from about 70,000 to 100,000 pounds per square inch with vitallium near 100,000 pounds per square inch, ticonium and niranium between 75,000 and 90,000 pounds per square inch, and lunorium about 70,000 pounds per square inch. The vitallium specimens quenched from 1000°C. were slightly higher in ultimate tensile strength than the "as cast" specimens, but the difference was so small that it may not be significant. The ticonium specimens appeared to be definitely improved by quenching from 1000 or 1093°C., reheating to 700°C., and then quenching.

The elongations were determined by fitting together specimens that had been ruptured in the ultimate tensile strength tests, and measuring the increase in length of an original 2-inch gage length in which the break occurred. The results are reported in percentage increase in length of the 2-inch gage length. As is seen in Table 6, the elongations varied from 4 to less than 1 per cent. No appreciable change in elongation was produced by heat treating the specimens.

For comparison, Table 6 includes the minimum tensile requirements of Federal Specification QQ-G-540, March 7, 1940, and Amendment 1, January 10, 1941, for Type IV extra hard gold alloys, suitable for dentures, bars and clasps. Gold alloys meeting the requirements of the specification have been furnished to the government. In ultimate tensile strength, only vitallium is above the minimum required of the gold alloys. The values for ticonium and niranium are close to the minimum requirement, while that for lunorium is far below the requirement. The specification requirement for yield strength is 65,000 pounds per square inch. Values reported in previous publications[15] indicate that gold alloys may exhibit yield strengths in excess of the required 65,000 pounds per square inch. (These values are reported as the "elastic limit," but were determined in the same manner as the yield strength values reported in this paper. According to present practice, "yield strength" is a better term for the property determined in the manner indicated. Also, it should be noted that in the testing of gold alloys for compliance with the Federal Specification, yield strength is not determined in the manner described in this report. However, the yield strength requirement of the specification is based on the yield strength as used in this paper.) None of the base metal alloy specimens tested, except the quenched and hardened ticonium specimens, cast by the manufacturer, averaged more than 65,000 pounds per square inch.

None of the four base metal alloys have elongations near the 10 per cent required of gold alloys in the softened condition. Most of the vitallium specimens and a few of the ticonium specimens, however, meet the requirement of the gold specification for elongation in the hardened condition. The fact that there is comparatively little difference between the elongation for these alloys in "softened" and "hardened" conditions farther illustrates that they are not very susceptible to heat treatment, as are the gold alloys.

The modulus of elasticity is higher for the base metal alloys than for gold. The federal specification does not have a modulus of elasticity requirement, but, from the other tensile requirements in the specification, it can be calculated that a modulus of elasticity of the order of 15,000,000 pounds per square inch is required. As stated before, the average modulus for the base metal alloys in-

cluded in this report is about 28,000,000 pounds per square inch.

Figures 3 and 4 show the relationship between ultimate tensile strength and Knoop hardness number and between yield strength and Knoop hardness number. In Figure 3, the points indicate that, in general, the higher the Knoop hardness number, the greater the ultimate tensile strength. Figure 4 does not show so definite a relationship between yield strength and Knoop hardness number.

CONCLUSIONS

1. Base metal alloys have come into use for prosthetic and orthodontic appliances because noble metals are not available or are expensive. To justify their use, base metal alloys must give service as good as or better than that of noble metal alloys.

2. Alloys having a copper, tin or silver base have not been satisfactory for cast dental restorations.

3. Alloys having an iron base, notably the wrought stainless steels, have proved to be very satisfactory for use in orthodontics and prosthetics. Data both from tests of physical properties and from practice show that, for certain purposes, such as tie wires in orthodontics, the stainless steels are as good as or better than noble metal alloys.

4. The cobalt-chromium alloys for cast appliances, lunorium, niranium, ticonium and vitallium, on which tests were made, were not in general superior to gold alloys in the properties which are included in this report. The base metal alloys are harder and stiffer than noble metal alloys. Gold alloys have higher values for ultimate tensile strength, yield strength and elongation than were obtained for most of the base metal specimens tested. The cobalt-chromium alloys are not so susceptible to heat treatment as are the gold alloys and cannot be softened for adjustment and rehardened for service as can the gold alloys.

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PLUMBISM

REPORT OF A CASE

By ALVIN T. LEVY,* B.A., M.A., D.D.S., Camp McQuaide, California.

FROM the time of its first use in industry, lead has been known to cause the disease called plumbism. To physicians of the Middle Ages, especially Tanquerel des Planches, in 1631, belongs the credit of the first correlation of the manifestations. Although lead poisoning today is an important industrial disease, the relative frequency of occurrence is very low.

The "lead line" of plumbism is of secondary importance in such a disease, but is very valuable in diagnosis. The line, which is due to a deposit of lead sulfide about the blood vessels in the tips of the papillae, appears very plainly about pyorrheic gums. When examined with an optical lens, it has a punctate appearance and seems to lie a little below the margin of the gum. A piece of paper inserted between the gum and tooth distinguishes typical stippling from staining of the tooth root. The peculiar localization differentiates this from other pigmentation of the mouth which is more diffused. The lead line is practically pathognomonic of lead absorption, but not of poisoning. It may persist for many months after exposure to lead has ceased. It must be distinguished only from a similar line produced by bismuth.

REPORT OF CASE

History.—C.C., a Chinese herbalist, aged 56, was admitted to the hospital with pain in the right flank of three years' duration, which was growing worse, with the complication of a reddish urine, occasional dysuria and nocturia (six to eight times). The patient gave a history of having been cared for by a private physician, with irrigations, pills and injections during the past seven years. Apparently, he had gonorrhea with a discharge, two or three years before. There was no swelling of the testicles at the time of examination. The patient spoke no English and was very uncooperative. He had tried all the Chinese herbs.

The family history was irrelevant. Vocationally, he was a Chinese pharmacist working in an herb store. He occasionally drank and smoked cigarets, but used no opiates He had had childhood diseases common in China. He had entered this country eleven years earlier. He gave no history and showed no scars of any previous operations or injuries.

Physical Examination.—The patient was well developed and well nourished. He was in no evident distress. The head was negative; eyes, grossly normal; hearing, good; septum, congested, intact and deviated to the left; teeth, fair; gingival tissue, showing a marked blue discoloration at the tooth margin; tongue, protruded in midline; tonsils, atrophic; pharynx, injected; voice, normal; no enlarged nodes or stiffness of neck; chest, well developed and symmetrical; heart, not enlarged and sounds of good quality and intensity; blood pressure, 145/88; lungs, clear on auscultation and percussion; abdomen, soft, showing no masses, spasm or tenderness; hernia, ring-tight; extremities, showing no edema or clubbing; genitalia, small and noncircumcised; scrotum and contents, normal; reflexes, sphincter tone good; prostate, small and non-tender; urine, slightly cloudy, light yellow, specific gravity, 1.05, slight trace of sugar, no albumin, very little sediment, no red cells, white and epithelial cells quite numerous, 500 per field, no crystals; blood examination: red cells per cubic millimeter, 3,500,000; hemoglobin, 70 per cent; white cells, 6,000 (polymorphonuclears, 62

*First Lieutenant (DC), U. S. Army.

From the Oral Surgery Department of Public Health, San Francisco General Hospital.

per cent, lymphocytes 34 per cent, large cells, 3 per cent, eosinophils, 1 per cent, basophils, 0).

Diagnosis.—The examination suggested (1) pyelonephritis, right; (2) renal calculus; (3) gingivitis with discoloration due to plumbism, and (4) secondary anemia. The diagnosis on discharge of the case was (1) hypertrophic arthritis and (2) plumbism and cystitis.

I have attempted through this typical case to present the local as well as general manifestations of a case of lead poisoning.

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SCIENTIFIC METHOD IN DENTISTRY

AN ORIGINAL FORMULA FOR ITS APPLICATION

VICTOR H. SEARS, D.D.S., New York, N. Y.

SCIENTIFIC method is a term for those processes used in investigating and solving the problems of science. It is a method used by the best minds of each generation in the modeling and remodeling of thought structures, resulting in the amazing progress of the human race. In this connection, it is interesting to see how formulas increase one's skill in dealing with problems, for the function of formulas is to aid and implement the powers of reason. The particular formula here presented serves as a scaffold for building complete thought structures, no matter how complex.

That the solution of a problem may require the use of trigonometry, the isolation of chemical elements or the counting of electrons does not mean that it is more scientific than many of our own problems, such as the casting of inlays to exact proportions. In the true sense of the word, dentistry is a science.

Under no circumstances should the solving of problems be regarded as "heavy thinking," fraught with anxiety. On the contrary, well-ordered thinking is one of life's most satisfying pleasures—a pleasure which does not diminish with indulgence. One is reminded of the saying attributed to Abraham Lincoln concerning firewood: "Chop your own wood, and it will warm you twice." So it is with skilful thinking. In itself, it is pleasurable, and the process stores up material for future enjoyment.

But to get the greatest enjoyment and to assure the best results, some guide, or plan, or method of attack, or formula is needed. Ideas are nebulous things at best, but when well arranged on paper, they are easier for the mind to grasp. Ideas cast into the formula here presented may not lead to final answers, but the answers will be more dependable than those arrived at without plan.

Of course, no thinking is done by the formula. It is merely a device for exposing a problem from all sides, and for organizing the material so that the mind can operate in an orderly and effi-

Read before the Section on Full Denture Prosthesis at the Eighty-Third Annual Meeting of the American Dental Association.

General Formula for Application of SCIENTIFIC METHOD

	OPENING OBSERVATION A	Why THIS STATEMENT IS OF INTEREST B	THE MAIN POINT C	EXAMPLES D	WHAT WE SHOULD DO ABOUT THE MAIN POINT E
SYMBOLS 1	Franklin called man a tool-bearing animal.	We use mental as well as physical tools.	Science needs a clear understanding of symbols because symbols are mental tools.	Musical symbols. Mathematical symbols. Word symbols.	Identify accepted symbols in order to apply scientific method. Devise new symbols if necessary.
PROBLEM 2	Man is faced with problems both physical and mental.	We need to understand the mental aspects of all problems.	Exact statement is an important step in solving a problem because exactness helps in the solution.	Euclid's "Elements"	Make aclear statement of the problem.
FACTORS 3	Facts are factors if they relate to the problem and if they are really facts.	We tend to drag in unrelated facts unless we make sure that each one bears on the problem.	All facts should be grouped because the mind grasps their significance better when they are arranged according to pattern.	Classifications Outlines Formulas Analyses	Clarify and group factors for quick and easy appraisal.
DEDUCTIONS 4	All planned action is based on deduction.	Progress is dependent on correctness of deductions.	Deductions will be correct largely according to how well we have fitted together the factors, because well articulated factors show up any missing data as well as point toward correct deduction.	Q. E. D. Synthesis Syllogism Completed cross-word puzzle.	Check to make sure that all conditions of the formula leading to deduction have been fulfilled. Make deduction or deductions.
INVENTION 5	No advances are made by mere checking.	We must not confuse learning with the original conception of ideas.	There is need of going beyond mere checking because many important problems are solved with imagination and many others (recognized or otherwise) remain.	Differential calculus Law of gravitation Vaccination Sugar from beets	Apply imagination for conceiving new ideas. Record theory so that it may be tested.

HORIZONTAL SPACES ARE PSYCHOLOGICAL STEPS .. VERTICAL SPACES ARE LOGICAL STEPS.

Fig. 1.—Completed formula serving as model for filling in spaces on similar diagram (Fig. 3) to prepare problem for systematic solution. The notations as here written in the spaces also constitute the outline of this essay.

cient manner. It will be recalled that scientists generally do their calculating on paper, and, in this calculating, they are dependent on formulas of numerous kinds.

In the formula here presented, the psychologic steps are arranged horizontally and designated by the letters A to E. As for the logical steps, they are arranged vertically and designated by the numbers 1 to 5. To determine whether all phases have been considered, one has only to glance at the filled-in formula.

It might be felt that it is not necessary to give consideration to so many phases of a problem, that, for example, one might well skip some of the first steps and begin, at say, 2E. There is something to be said in favor of this contention, especially in simple problems dealing with familiar subjects. On the other hand, it is well known that the way to learn a subject is to expound it; the way to understand is to explain. Indeed, the complete exposition of all phases may turn on new and important aspects which would otherwise be slighted or overlooked entirely.

Subjects of all kinds varying from esthetics to government projects are grist for the mill, but, in our present discussion, which is intended to show a scheme for implementing scientific method, we follow the general formula. (Fig. 1.) All of the spaces in the diagram were first filled in, and then this discussion was written from the sequence thus developed. It will be helpful to note the legend in each space of the diagram, and then to follow the elaboration in the text. The designations 1A, 1B, etc., of the diagram correspond to like designations in the text.

(1) SYMBOLS

1A. Benjamin Franklin pointed out that man is a tool-bearing animal, and that his ability to use tools gives him an enormous advantage over all other animals and his environment.

1B. We become more skilful as we master the available tools and devise better ones—not just physical tools, such as handpieces, engines and articulators, but also symbols, which are mental tools. In many cases, symbols are infinitely easier to handle than the things for which they stand, and, without them, there could be no scientific method.

1C. Each science needs its selection of tools, all sharp and easily available. Just as physical tools are required in the *art* of dentistry, so are mental tools necessary in the *science* of dentistry. It is essential to grasp the significance of symbols in general and of some symbols in particular because they are necessary in stating, solving and explaining problems.

Symbols, which are more or less arbitrary signs, should never be confused with the things themselves. The word "flower," for example, has none of the attributes of the thing itself, but has significance to English-speaking persons because of common agreement. A sign is a symbol to one who understands what it designates, but may be quite meaningless to others. It can be a sign, but it cannot be a symbol unless it is linked to *the* thing for which it stands, and, in writing, it cannot be a useful symbol to convey meaning unless writer and reader link it to the same thing.

1D. Mathematical symbols are among the most precise. The figure 9, for example, means the same definite quantity under all circumstances to all men. Other symbols are chemical formulas, musical signs, blueprints, maps, graphs, diagrams and words. Some minds grasp one type of symbol best and some another, but, in general, symbols reinforce one another so that at times several kinds should be used together.

Of all symbols, words are the most generally useful, but often the least exact. Whereas the figure 9 in mathematics, a dot on the staff in music or the formula H_2SO_4 in chemistry conveys exact meanings, such symbols as "restriction"

The spaces are filled in below to indicate how this Formula can be employed for solving the problem of "Prosthetic Occlusal Forms". The Formula also serves as an outline for discussing the subject.

SYMBOLS PROBLEM FACTORS DEDUCTIONS INVENTION

	OPENING OBSERVATION A	WHY THIS STATEMENT IS OF INTEREST B	THE MAIN POINT C	EXAMPLES D	WHAT WE SHOULD DO ABOUT THE MAIN POINT E
1	Progress in a science depends on suitable symbols.	Prosthetics needs greater care in the use of symbols (terms).	Terms used must mean the same to all, because indefinite terms lead to indefinite thinking.	Relation, Articulation, Occlusion, Working occlusal, Balancing Occlusal, Sub-occlusal.	Define all terms exactly.
2	Dentists have not yet solved the problem of occlusal forms.	Profession looks to denture men to find the solution.	The problem of producing superior forms needs clear statement because, only then can effort be directed intelligently.	What would be ideal forms for preservation of tissues, for efficiency and for esthetics?	Set up clear and comprehensive specifications.
3	Irrelevant facts (especially anatomic facts) have been introduced into previous discussions.	Only a strict adherence to relevancy will avoid confusion.	All factors should be assembled and arranged for study because this will afford a better grasp of the problem.	Mechanical, Physiologic, Anatomic, Esthetic.	Assemble and grasp all factors.
4	Some men have passed judgement without study and without testing.	This attitude has delayed progress.	Study and experiment are needed to select most suitable forms.	Some of the forms now available.	Test the forms selected on the basis of deductions.
5	Using the best forms now available should not mark our stopping point.	Profession is expecting better forms.	It is not enough to use the best forms available, because imagination can be used for further advance.	Steady improvement in automobiles and air planes.	In light of present deductions apply imagination for additional gains.

Fig. 2.—Formula filled in to prepare problem of "prosthetic occlusal forms" for solution, for discussion or for both.

or "freedom" mean different things to different individuals and even to the same individual under different circumstances.

To be sure, a single word is frequently a frail and undependable tool, but any word can be strengthened and sharpened by means of other symbols, including other words. To clarify thinking and discussion, we should fortify words with word definitions, pictures, tables, diagrams and graphs. This is not a requirement in such practices as passing the time of day or writing poetry or love letters, but, in scientific discussions, the meticulous use of symbols is a special requirement. We need to guard against saying "blankety-blank" when that symbol may stand for "blinkety-blink" in the minds of others.

That we do this is seen in some of the foggy discussions where, for example, we try to talk about three different things such as "articulation," "occlusion" and "relation" without restricting the three symbols to their respective concepts. When we mix our symbols, we mix our thinking.

Equally confusing are the instances in which we run counter to generally accepted meanings, as in such dentally popular words as "periphery." Periphery is generally agreed to mean a line (not a border) which marks the outer extent of some regular figure such as a circle or an ellipse. To refer to the "lingual periphery" of a dental impression does the same sort of violence to symbols as does the term" "pinnacle of profundity." It is not greatly different from the "classical" Hollywood remark: "You can include me out."

"Gothic arch tracing" is another incongruity. The "gothic" part can refer only to the distinguishing feature of gothic architecture, but when a tracing is made by the needle point attached to a lower jaw, it is nothing like the arches known to the Goths. "Needle point tracing" is a better symbol.

If scientists insist on the use of precise terms and other symbols, it is not that they wish to split hairs, but that thinking is facilitated and progress more satisfactory when appropriate labels are used. Scientific method demands good tools.

It also requires a sufficient number of tools. Among the mental tools, each science, such as dentistry, biology and chemistry, finds the need for about 2,000 special symbols, including special words. On behalf of broad education, it should be pointed out that the more symbols we acquire, the greater selection of tools we have. Each new science, even each new language makes us better equipped as problem solvers.

1E. And so the first logical step in applying the formula is to select, amplify, modify or invent symbols with fixed and understood meaning.

(2) PROBLEM

2A. Our problems are at the same time mental and physical, but they are always basically mental. Scientific method sometimes requires the use of equipment such as test tubes, microscopes and scales for purposes of detecting, observing and measuring, but these are merely physical tools for sharpening the senses.

2B. The fact that our problems are both mental and physical demands that our handling of them be likewise mental and physical. In the non-physical operations as well as in the physical ones, we need appropriate technics.

2C. Because of the essentially mental constitution of a problem, we need to identify and formulate its mental aspects so that we can proceed intelligently. Without a suitable formula, we may even be unable to grasp the essentials of the problem, and thus fail to arrive at a satisfactory solution.

Our greatest problem solvers are the scientists. They do not work by haphazard methods, but use special technics. Especially is this true of our research

organizations, wherein clear statement of a problem is a recognized step in the procedure; for only when a problem is stated so clearly that it cannot be misunderstood is it prepared for solution.

Of course, trained thinkers make clear statements more or less unconsciously. But, in scientific method, all of the thought processes should be conscious, or at least directed by consciously developed habits.

Occasionally, all that is needed is a well-formulated statement or a direct question. The problem should be written out in as many forms as occur to the mind and the best form adopted. This in itself will often indicate the solution or show that the problem cannot be solved at all or that it has no significance anyway and should, therefore, be abandoned.

2D. An outstanding example of precise statement is Euclid's "Elements," a book of problems stated so clearly that it was used as a text without alteration for more than 2,000 years. There is nothing ambiguous about Euclid. Knowing the symbols, when we read one of his problems, we know exactly what the problem is.

2E. Of course, all of our problems cannot be stated with the same exactness as those in arithmetic and geometry, but to locate the goal, we should state each problem with the greatest possible clearness. Once the goal is located, we are ready to assemble the factors.

(3) FACTORS

3A. By factors, I mean all of the things which contribute to make the situation what it is. Only those facts which relate to the problem are factors. This poses several questions:

1. Are they really facts?
2. Do they apply to the problem?
3. Are they important enough to affect the solution?
4. Are there other factors which should be discovered?

3B. Such questions tend to weed out unrelated and unimportant matters and to garner the usable ones. Without this, we are prone to drag in extraneous matter and overlook some of the essentials.

To judge the importance of factors, each one must be thoroughly identified and made to stand out clearly. Any uncertainty as to the exact nature of a factor blurs the problem itself, and endangers the validity of the solution. Take, for example, a problem like the following:

"John had three apples, but ate two of them. How many apples has he left?" Both problem and factors are clear. The same problem stated vaguely might read:

"John had a cheerful disposition and a pocketful of apples, but ate some of them. What has he left?"

This second example appears ridiculous, especially by comparison with the first one, but it emphasizes the importance of including all of the essential factors and only those that have significance.

3C. With a good selection of well-defined factors to work on, an essential step in scientific method is to arrange them for easy comprehension. Especially in the more complex problems is it necessary to organize the factors in such a pattern that the mind can grasp their significance. It is not enough to merely contemplate the factors: they must be contemplated in their relation to one another.

The trial arrangement of factors according to different plans is primarily in the nature of mental experimentation. So-called physical experiments are physical phenomena made to order. Where the scientist can only grope among observed but uncontrolled phenomena, he can stride by the aid of experiments. It is similar with mental operations: Where the thinker is bewildered by miscellaneous factors, he can advance with confidence when he organizes these factors

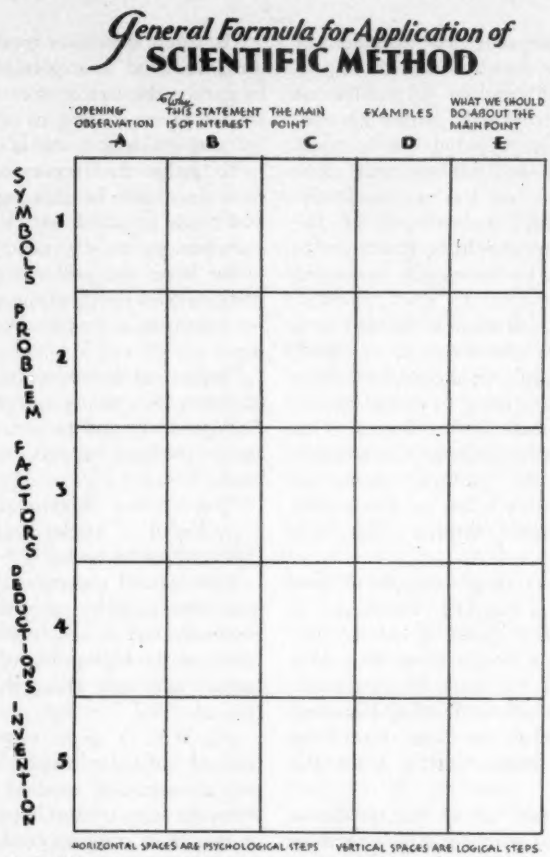

Fig. 3.—Formula in blank for handling of any scientific problem. The spaces are to be filled in with notations similar to those shown in Figures 1 and 2. To work out a specific problem, the spaces are filled in according to the following plan:

Read 1A, 1B and 1C of the general formula (Fig. 1). Then write in space 1D (Fig. 3) the important symbols needed for handling the subject. Only the terms or other symbols which come to mind readily are written in at this time, but others may be added if necessary as the method develops. If new symbols can be devised to clarify meaning, do not hesitate to invent them.

1. In space 1E, define the symbols listed in 1D. (If the space on this form should be too small, definitions are made on a separate sheet). Be sure that each symbol stands for a definite concept. For most problems, the symbols are words; in which case, each term should be defined so clearly that its meaning is unmistakable. This is a highly important step in clear thinking and a matter which most of us are too prone to take for granted.

2. In space 2E, state the problem as exactly as possible.

3. Group the factors in the space 3E. This may require trying several arrangements, such as classification, outline, analysis and graph.

4. Write in space 4E any deductions which appear reasonable from the preceding steps.

5. Write in 5E any theory or surmise which comes to mind as the outgrowth of the previous steps, remembering that inhibition is the enemy of discovery and invention. At this point, the imagination should be given free rein and no matter how wild the notion, it should be recorded. Write down every imaginable theory or fancied discovery and do not hesitate if the idea seems ridiculous. Judgment should not interfere with theorizing until after fancy has run its course.

(Legend continued on next page.)

intelligently. Although we speak of organizing the factors as the third logical step, it must be remembered that the units which we arrange are not the factors themselves, but the symbols which represent them.

3D. There are several schemes according to which factors (or, strictly speaking, symbols) can be arranged. Some problems lend themselves better to one arrangement and some to another. Some minds grasp one type of arrangement better than another.

One of the oldest and most helpful of arrangements is classification. Outline is another form of grouping. Formulas, such as those used in chemistry, and explanatory drawings are thought patterns to shortcut and implement the thinking sequence. Classifications, outlines and diagrams are important devices for understanding and solving problems.

The formula here presented incorporates the essentials of classification, outline and diagram. It is also designed to harmonize with both the psychologic and the logical operations of the human brain, a harmony not always found in our thought processes. We say, for example, "go, went, gone"; whereas logic would require "go, goed, have goed."

To indicate how the psychologic and the logical phases are handled and how the factors are handled in a specific dental problem, the subject "Prosthetic Occlusal Forms" has been cast into the formula. (Fig. 2.) All parts of the diagram have been filled in to show how the steps are taken for easy comprehension and logical consideration. "Prosthetic Occlusal Forms" has not been elaborated into an essay, as well it might be, but is presented here merely as an example of specific application. The formula is also shown in blank (Fig. 3.), to be applied to any complex problem.

3E. For discovering voids and for better grasping the problem, we need to arrange the factors according to a well conceived pattern.

(4) DEDUCTIONS

4A. Acceptable deductions are the first fruits of scientific method. Except for instinctive action, which is unreasoned, all action is based on deduction.

4B. Only when deductions are logical will action be reasonable. Progress in the sciences, even success in life itself, is dependent on the correctness of deductions, so that, in the solution of any problem, the arrival at deductions is a step of the utmost importance.

4C. Deductions will be correct largely according to the degree of care with which we have fitted together the factors and grasped their significance. Well-articulated factors not only help to disclose any missing parts: they constitute a pattern for intelligent deduction.

But even intelligent deductions are open to question. Except where *all* factors are included, as in mathematics, it cannot be emphasized too strongly that every deduction is tentative, being subject to revision in the light of any new factors disclosed. Without being necessarily final, a deduction may be tenta-

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All of the ideas thus projected having been recorded, judgment should reenter. Examine all of the written speculations in the light of past thinking and discard those which are useless. Compose the remaining speculations into the most logical theory or conviction of discovery. Such theory or conviction of discovery should be written completely. Its meaning should be clear to all so that it may be submitted for tests by oneself and others.

With the E column thus filled in, further gains are possible in many cases through completing the entire formula, filling in all of the spaces. It will be appreciated that this formula is a pattern for the complete explanation to others of one's theory, hypothesis, discovery or invention and can serve as an outline for any report, essay or book on the subject. But where no recording is contemplated for the benefit of others, the very writing down of the various phases exposes the subject from all sides to the mind of the thinker.

tively acceptable, for it is the history of progress that highly regarded deductions have required revision again and again as new factors are discovered.

4D. A classical example of deduction is the Q.E.D., or proof of a problem in geometry. Verbal deduction is exemplified by the well known syllogism: "All men are mortal. Socrates is a man. Therefore, Socrates is mortal." The completed crossword puzzle embodies a whole set of deductions. These are examples of reasoning from the general to the particular; a matter distinct from "invention," which is the final step in the formula, and which will be discussed presently. Having arrived at a deduction, we have merely reasoned our way to some conviction on which to base a judgment and possibly an action. In most instances, we have done nothing more than follow exactly in the steps of others.

4E. This is not to say that arriving thus at deductions is an unimportant accomplishment, for we come this far with the guidance of others before we can forge ahead alone. This catching-up process leads us to the brink of discovery and invention. To be certain that we have really caught up, we test ourselves by means of the formula, checking each step and recording our deductions.

(5) INVENTION

5A. No progress is made in science, nothing new is added to the sum total of knowledge, by merely checking the advances already made.

5B. It is important to bear this fact in mind so that we do not confuse learning, which is the acquisition of knowledge already in existence, with original thought, which is invention. So far as mere learning is concerned, it stops with deductions and contains no element of originality.

5C. To make progress, there is need for going beyond mere checking or verifying. It is by invention, by projection of thought beyond verifying, that science makes advances. Invention is the product of imagination and imagination is the juggling of memories, but the exercise of imagination without a background of acceptable deductions is fraught with dire possibilities.

It requires something more than accumulation of facts and valid deductions for valuable invention. For each individual who can devise a machine, there are thousands who can operate it. For one who can invent a process, there are thousands who can employ it. For one who can formulate a working hypothesis, there are thousands who can only check.

5D. Machines, processes, plans, languages, formulas, governments, organizations of all kinds are inventions. Even a theory is an invention. A theory, a speculation or guess based on deductions, becomes a working hypothesis when it has been formulated so that its validity can be tested. The working hypothesis serves as a device for proving or disproving a theory, but once the hypothesis has been established, it is no longer a hypothesis. It then becomes another deduction, on which other theories can be projected.

In the field of mathematics, Leibnitz built on previous deductions and invented a branch known as the calculus. The law of gravitation is a clear and fully recorded example of invention. Kepler, following the trail blazed by Pythagoras and Copernicus, had already shown that the movements of celestial bodies conform to certain laws, but Newton reduced these laws to a single one known as the law of universal gravitation, hailed as the greatest achievement in the history of science. Even so, Einstein was able to add further refinements. Jenner, Pasteur, Semmelweiss and Banting are among the medical inventors who formulate hypotheses. In the field of chemistry, there is nothing about the appearance or taste of beets which would suggest them to the ordinary individual as a source of sugar,

but scientists have produced beet sugar. It was by scientific method that burning and rusting were found to be essentially the same process, and, more recently, that hemoglobin and chlorophyl were shown to be analogous; facts which were first imagined and then verified.

5E. In all sciences, we need to apply the same procedure: imagination, formulation and verification. When we contemplate the fact that physicists have predicted the discovery of elements and have described them minutely before these elements were even found; when we observe that astronomers have foretold not only the exact moment of an eclipse, but have located and described heavenly bodies before it was possible to see them, and have fixed the distance from earth, rate of travel and even chemical composition of other bodies inconceivably far away; and when scientists in other fields have performed similar exploits, this record gives promise of our ability to solve such problems as "prosthetic occlusal forms," already mentioned, as well as others.

CONCLUSION

If a scientist is one who attacks his problems scientifically, we can all be scientists. We have at hand a convenient means of investigating, solving and explaining our problems. By (1) identifying the symbols, (2) stating the problem, (3) integrating the factors, (4) making deductions and (5) using imagination, all according to the formula here suggested, it is possible for us to build a greatly expanded dental science.

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RECOVERY OF AMELOBLASTS

JOSEPH P. WEINMANN, M.D., Chicago, Ill.

INTRODUCTION

IT IS known that enamel hypoplasia can be produced experimentally by various injuries. It is generally accepted that enamel hypoplasia is caused by a primary lesion of the ameloblasts. However, there is no evidence pointing to a process of repair of injured ameloblasts. It has been assumed that the latter were beyond recovery.

A sharply outlined enamel hypoplasia of the rat incisor can be produced by injections of a single dose of strontium chloride. This method makes it possible to trace the injury throughout the entire life span of the damaged cells. In the course of the studies described herein, changes could be observed in a well-defined zone characterized by a disorganization and degeneration of the ameloblasts. Advanced stages of the injury furnished evidence for reorganization and recovery of the ameloblast layer.

REVIEW OF THE LITERATURE

The histopathology of enamel hypoplasia has been studied in both human and animal material. In most instances, the cause was of a chronic nature and unknown intensity and duration. The hypoplastic lesion was caused by a deficiency in vital growth essentials[1, 2, 3, 4, 5, 6, 7] or hormones,[4, 7] pathologic conditions such as syphilis,[8, 9] tuberculosis[7] and fluorosis[10, 11] or trauma,[12, 13] or was genetic.[14]

The method used in this study, that of tracing the changes in the enamel at various intervals following a single injection of a poison, was previously employed in a study on the effect of fluorine.[11]

The majority of students of the histogenesis of enamel hypoplasia agree that it is caused by a disturbance of the ameloblasts. However, only a few investigations have dealt with the nature of the initial stage[7, 9, 11, 13] and no records appear to be available tracing the fate of the ameloblasts over a longer period after acute injury.

Strontium has chemical properties similar to those of calcium. For this reason, numerous pharmacologic studies of strontium as a substitute for calcium have been made.[15, 16, 17, 18] It has been known for the last half century that the addition of strontium to the diet of experimental animals causes a bone disease similar to rickets.[19, 20, 21, 22, 23, 24, 25, 26, 27, 28] The influence of strontium on the enamel organ has not as yet been investigated, although changes in rat incisors have been observed in studies dealing with the effect of strontium on bone.[26, 29, 30, 31]

METHOD AND MATERIAL

The present report is based on studies of the upper incisors of thirty-eight rats. These animals were given a single subcutaneous injection of 1 cc. of 20 per cent strontium chloride solution, and were killed at intervals varying from three hours to twenty-eight days. Four control rats were injected with 1 cc. of physiologic sodium chloride solution.

Albino rats, bred from Wistar Insti-

From the Foundation for Dental Research of the Chicago College of Dental Surgery.

Read before the International Association for Dental Research, Chicago, March 12, 1943.

tute stock, were fed dog chow (Purina). This diet was augmented twice a week by the addition of lettuce, carrots and dry bread crust. The animals were kept in a light room, from three to five in a cage. They were weighed at the beginning and, most of them, at the end of the experiment. If the experiment extended over a week or more, the animals were weighed once a week.

Strontium chloride, purified, was dissolved in distilled water to a concentration of 2 per cent. The injections were given subcutaneously and under aseptic conditions. The animals were killed by prolonged narcosis with chloroform. The specimens were immediately fixed in Zenker-formalin (Maximow) solution for one day or Bouin's solution for two days. One-half of the upper and lower jaws were decalcified in 5 per cent nitric acid, embedded in celloidin, stained with hematoxylin eosin or Mallory's stain or impregnated with silver. The accompanying table presents data on the animals used in this experiment. As the animals varied in age and weight, the relation of the injected amount of strontium to the weight differed, although all animals were injected with the same amount of strontium chloride solution. Younger and smaller rats received a relatively

Data of 38 rats injected with 1 cc. of 20% $SrCl_2$ solution and arranged in order of dosage (mg. per kg. body weight) and length of experiment.

Pro. No. of rats and sex	Litter	Age in weeks at start	Weight at start	Weight at end	Mg. $SrCl_2$ per kg. body wt.	Length exper.
426 ♂	A	11	178		1100	3.40 hrs.
427 ♂	A	11	176		1100	7.20 hrs.
428 ♂	A	11	203		1000	14.30 hrs.
429 ♂	A	11	199		1000	19.10 hrs.
66 ♂	B	12	250		800	24 hrs.
67 ♂	B	12	256		750	2 days
68 ♂	B	12	281		700	3 days
71 ♀	B	12	160		1200	5 days
72 ♀	B	12	176		1100	6 days
73 ♀	B	12	183	172	1100	7 days
74 ♀	B	12	196	204	1000	8 days
75 ♀	B	12	182	176	1100	10 days
453 ♀	C	13	128		1500	28 hrs.
454 ♂	C	13	121		1600	52 hrs.
455 ♀	C	13	109		1800	3 days
456 ♂	C	13	110		2000	4 days
457 ♀	C	13	100		2000	7 days
458 ♀	C	13	98		2000	8 days
133 ♂	D	6	74		2800	1 hrs.
150 ♀	E	6	54		4000	1 hrs.
140 ♂	D	6	80	89	2500	24 hrs.
148 ♂	E	6	82	79	2500	32 hrs.
131 ♂	D	6	77	66	2500	45 hrs.
132 ♂	D	6	84	87	2500	53 hrs.
146 ♀	E	6	75	74	2500	3 days
130 ♂	D	6	75	81	2500	4 days
135 ♀	D	6	63	78	3300	5 days
143 ♀	E	6	62	80	3300	7 days
137 ♀	D	6	68	83	2800	8 days
145 ♂	E	6	65	87	2800	9 days
134 ♀	D	6	59	78	3300	10 days
141 ♂	E	6	65	112	2800	14 days
136 ♀	D	6	63	100	3300	16 days
147 ♂	E	6	68	130	2800	18 days
144 ♀	E	6	45	92	4000	21 days
138 ♂	D	6	56	121	3300	23 days
149 ♀	E	6	72	126	2800	25 days
139 ♀	D	6	58	120	3300	28 days

higher dose than older and larger animals. The experimental animals were grouped according to the dosage (milligrams per kilogram of body weight).

FINDINGS

A. *General Effects.*—Two rats injected with a dose of 2,800 and 4,000 mg., respectively, per kilogram of body weight died (table, R133 and 150) one hour after the injection. All animals showed a severe reaction at the site of the subcutaneous injection. Gross anatomic and histologic investigation of this area revealed necrosis of the subcutis, sometimes exending toward the adjacent muscles and the cutis, and resulting in a cavity filled with serum or an ulcer of the skin. The necrotic area was found to be demarcated by a wall of leukocytes and granulation tissue. After two weeks, the local injury had healed, with scar tissue.

B. *Normal Histology of the Enamel Organ.*—The rat incisor is a continuously growing and erupting tooth. Its apical end is always found in an embryonic state. Progressive differentiation follows the developmental changes in the enamel organ and the tooth incisally. The changes in the cells of the enamel organ are gradual. It is understood that these changes represent, on one and the same

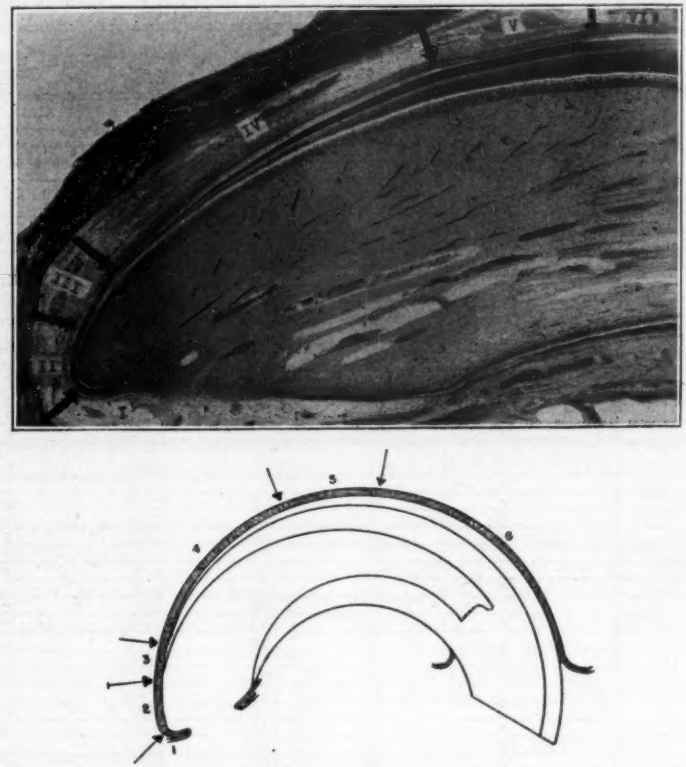

Fig. 1.—Sectors of rat incisor in control animal; apical end of rat incisor. (See diagram.) Sector four is the area of enamel formation and initial change after injection of strontium chloride solution.

tooth, different age levels of the enamel organ. In spite of the continuity of these changes, it is possible to divide the whole enamel organ into six sectors, according to morphologic and functional differences.

The first, or apical, sector, the epithelial diaphragm (Fig. 1, I), measures about 0.4 mm. In the first sector, the outer and inner enamel epithelium and the intermediate layer of multiform cells can be distinguished. This is the area where the most marked mitotic activity can be observed.[32]

tion has started. Here, the ameloblasts are characterized by the shifting of the nuclei toward the periphery of the cells. (The terminology of the two poles of the ameloblasts is contradictory. The ameloblasts develop from the basal layer of the oral epithelium. It seems, therefore, justified to call the end of the cell, resting upon the connective tissue, the basal end; the opposite end, in contact with the stratum intermedium, the peripheral end.[33]) The *stratum intermedium* consists of two or three rows of cells. Toward the ameloblasts, the surface of the newly

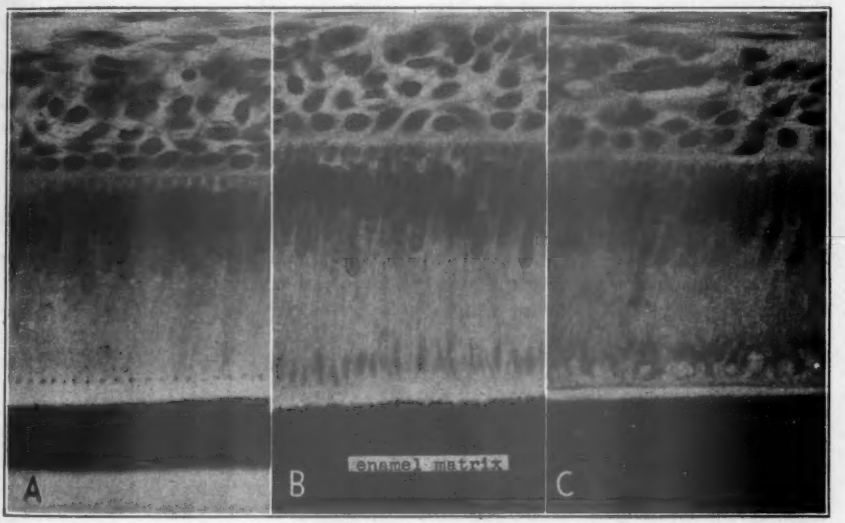

Fig. 2.—Ameloblasts of sector four. At A, the apical zone, the cytoplasm is evenly granulated. At B, the middle zone, an intensely stained area is seen at the basal end of the cell, adjacent to the enamel matrix. At C, the incisal zone, vacuoles are seen at the basal end. (×750.)

The second sector, which extends to the beginning of dentin formation (Fig. 1, II), measures from 0.3 to 0.4 mm. The enamel organ in this area is characterized by the differentiation of distinct *stratum intermedium* cells. The ameloblasts are in contact with the differentiated odontoblasts.

The third sector (Fig. 1, III), which is from 0.5 to 0.7 mm. in length, corresponds with the area where dentin formation has started. Here, the ameloblasts are characterized by the shifting of the nuclei toward the periphery of the cells. (The terminology of the two poles of the ameloblasts is contradictory. The ameloblasts develop from the basal layer of the oral epithelium. It seems, therefore, justified to call the end of the cell, resting upon the connective tissue, the basal end; the opposite end, in contact with the stratum intermedium, the peripheral end.[33]) The *stratum intermedium* consists of two or three rows of cells. Toward the ameloblasts, the surface of the newly formed dentin is covered by an extremely thin line intensively stained with hematoxylin. It may represent the dentinoenamel membrane,[34] which is supposed to provide an attachment between dentin and enamel.

The fourth sector (Fig. 1, IV) shows the ameloblasts at the height of their function of forming the enamel matrix. This sector, which is about 2 mm. long, extends from the beginning of en-

amel formation to the point where the enamel has reached its ultimate thickness. It is this sector exclusively in which enamel matrix is formed. The ameloblasts (Fig. 2) are long and thin. The peripheral portion of the cells is stained intensively red with eosin.[35] The oval-shaped nucleus lies in the peripheral third of the cell. The longer basal portion of the cell is not of uniform structure throughout sector four. In the apical zone of this sector, where enamel formation has just started (Fig. 2, A), the basal part of the cell is stained purplish with hematoxylin-eosin and is filled with evenly distributed, fine granules. In the middle zone (Fig. 2, B), the cytoplasm of the ameloblasts shows a dense area at the basal end which is stained dark with hematoxylin. In the incisal zone (Fig. 2, C), vacuoles appear in the basal part of the cells. The *stratum intermedium* is reduced to one row of cuboid cells.

The fifth sector (Fig. 1, V), which is from 0.9 to 1.2 mm. in length, extends from the point where the enamel matrix has reached its ultimate thickness to the area where it becomes soluble in 5 per cent nitric acid. The difference in chemical reaction is explained by the difference in the amount of mineral salts and organic substance in enamel matrix and mature enamel. Enamel matrix is about 25 per cent mineral salts and 75 per cent organic substance and water. Mature enamel is 98 per cent mineral salts and 2 per cent organic substance and water.[36] The border between the fifth and the sixth sector is not sharply outlined, the transition from soluble to insoluble enamel being gradual. The ameloblast is reduced in length and closely attached to the enamel matrix, and has a granulated cytoplasm. The cells of the *stratum intermedium* have lost their uniform arrangement and are spindle-shaped.

The sixth sector (Fig. 1, VI), which is about 15 mm. long, and is characterized by the solubility of the enamel in 5 per cent nitric acid, extends up to the incisal edge of the tooth. The ameloblasts retain their cuboid shape to the level of the alveolar ridge. In the middle of the sixth sector, the ameloblasts contain pigment granules in the basal part of the cytoplasm.

C. *Shift of the Hypoplasia During Eruption of the Tooth.*—Enamel hypoplasia, following injection of strontium, is due to cessation of enamel matrix formation in the entire fourth sector. In sector three, the younger ameloblasts are not damaged. When they differentiate further and shift into sector four, they produce normal enamel matrix. The border between the hypoplastic enamel and the newly formed normal enamel marks the apical end of the hypoplastic zone. The incisal end of the hypoplasia is discernible as an obtuse angle between the hypoplastic and the fully developed enamel matrix, which, at the time of the injection, was located in sector five. Another means of recognizing the incisal border of the hypoplasia, by changes in the ameloblast layer, will be described later. The distinct border lines of the hypoplastic zone make it possible to follow the shift of this zone during tooth eruption.

The hypoplasia reaches the border between the fifth and sixth sector (the border between insoluble and soluble enamel) about five days after injection. As long as the hypoplastic enamel is in the sector of insoluble enamel (Sector V), the prospect of this hypoplastic lesion as to calcification is indefinite. When, after the fifth day, enamel hypoplasia reaches the sector where the change to solubility occurs normally, it becomes apparent that the maturation of the enamel, in the hypoplastic area, is disturbed. Specimens secured after the fifth day show an increase in length of the insoluble portion of the enamel. At the end of the second week, the basal end of the hypoplasia has shifted to the border between the fifth and the sixth sector. Thereafter, an area of soluble

enamel is seen between the incisal end of the fifth sector and the basal end of the area of hypoplasia. (Fig. 3, A.) This area increases as the hypoplasia shifts incisally. (Fig. 3, B.) The hypoplastic enamel remains insoluble in 5 per cent nitric acid even the longest period of observation (twenty-eight days).

D. *Detachment and Reattachment of the Enamel Organ.*—Three hours after injection (Fig. 4, A), the enamel organ is detached from the enamel matrix in the portion of the fourth sector nearest the apex. Fourteen hours after the injection, the detachment extends farther toward the incisal border of sector four. Between nineteen and twenty-four hours after the injection (Fig. 4, B), the pathologic condition seems to have reached its peak. In the space adjacent to the enamel organ, degenerated cells and cell débris are found. A layer of faintly coagulated fluid, adhering to the enamel, can be observed in some specimens. The enamel matrix is covered by irregular droplets or a layer of amorphous calcified material.

Since the detachment extends exclusively over the entire length of the area of hypoplasia, the progressive changes of the detached enamel organ have to be correlated to the hypoplasia area, and not to the different sectors. Beginning with the second day (Fig. 4, C and D), detachment decreases from the incisal border of the hypoplasia area toward the apical end. After the fifth day (Fig. 4, E), the enamel organ is reattached in all animals along the entire length of the hypoplasia area.

E. *Changes in the Ameloblasts.*—The first changes in the ameloblasts are found exclusively in sector four, the same region to which the enamel hypoplasia and the detachment were originally confined. The initial changes in the ameloblasts were observed between fourteen and nineteen hours after the injection. (Fig. 5, A.) Three morphologic characteristics of the pathologic process could be differentiated at the initial stage. The first and most striking change is the reduction of the ameloblasts to about a third of their length. The second is the

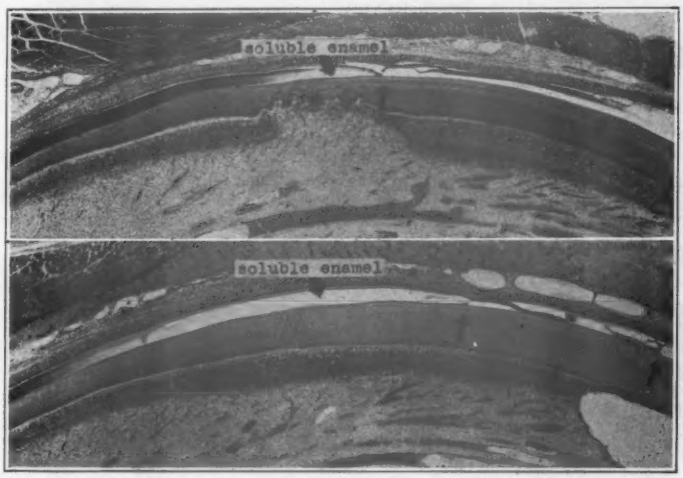

Fig. 3.—Shift of hypoplasia into sector six (soluble enamel). The hypoplastic enamel (between arrows) remains insoluble. Soluble enamel is found between the area of hypoplasia and sector five. This area is short in A, longer in B.

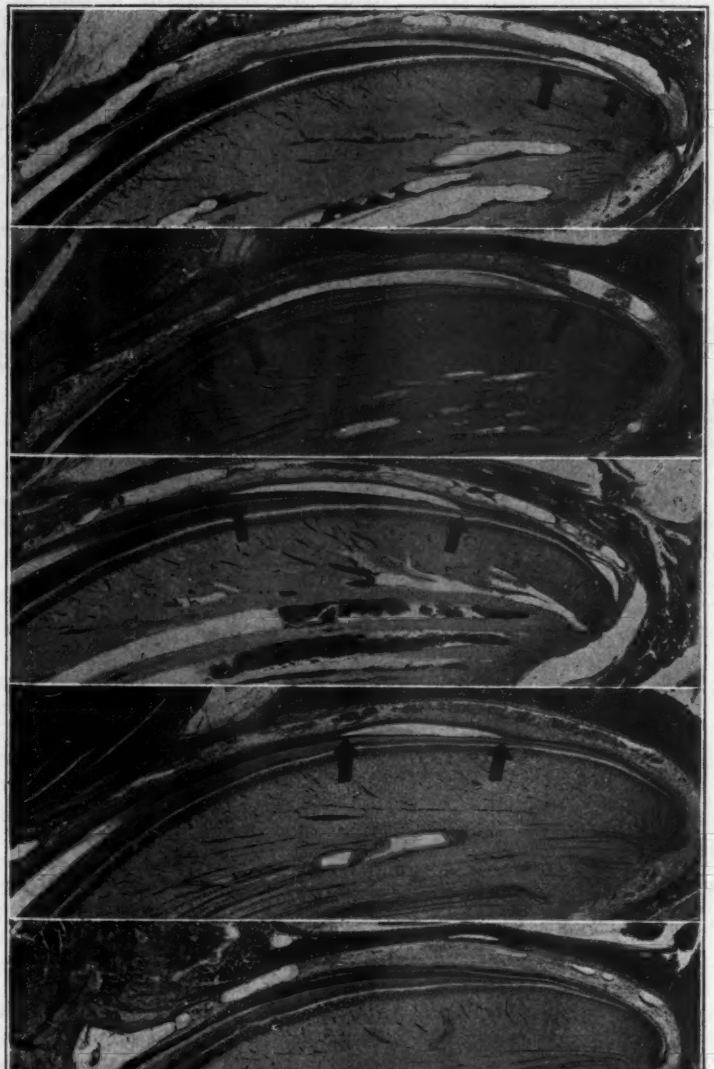

Fig. 4.—Detachment (ablatio) of enamel organ, which increases gradually up to twenty-four hours (A and B). Reattachment (C and D) is complete five days after injection (E). A, at three hours; B, at twenty-four hours; C, at three days; D, at four days; E, at ten days.

appearance of a darkly stained area at the basal end of the ameloblasts. This phenomenon appears to be an exaggeration of the physiologic occurrence typical of the middle zone of the fourth sector. The third characteristic is the shifting of some of the peripherally located nuclei to the basal end of the ameloblasts. These changes are most severe in the apical part of sector four and gradually diminish toward the incisal border of this sector. They are accentuated in small restricted areas. In these foci, the ameloblasts are reduced in length even more than in adjacent areas, and the cell borders are no longer distinguishable. (Fig. 5, A.) Shape, size and the ability of their nuclei to stain are at first unchanged. The cells bordering such a focus incline toward the affected group of cells. At this stage, no morphologic changes are observed in the *stratum intermedium* or in the outer enamel epithelium.

In the later hours, all the changes described have advanced. Foci of disintegration are more numerous. (Fig. 5, B.) The peripheral end of the ameloblasts stains more intensely; whereas the nuclei, not noticeably changed in shape and staining reaction, have moved farther toward the basal end of the cells. The cells adjacent to the area of cell disintegration are still farther inclined toward the defect. Between the ameloblasts and enamel matrix, a layer of faintly stained globuli can be seen.

After the first day, the ameloblasts are found to be affected to a varying degree. The ameloblasts adjacent to a focus of cytoplasmic disintegration have closed the gap almost entirely and lost their normal orientation, and the cuboid cells of the *stratum intermedium* have flattened. In some areas, scarcely a single cell can be identified as an ameloblast. (Fig. 5, C.) Only small remnants of cytoplasm surround the nuclei, which are oriented in different directions. Some of the nuclei are of normal shape and staining reaction, whereas others have lost these qualities to various degrees. Some appear to be in a state of disintegration. The injection of strontium does not seem to affect all the cells in sector four at the same time, or to the same degree, but rather affects groups of cells at different periods, resulting in the development of scattered foci in various stages of pathologic development. Occasionally, the foci are separated by ameloblasts of fairly normal structure.

The focal changes observed in animals killed during the first day, after injection, progress during the next twenty-four hours until the entire fourth sector is uniformly affected. At this period, two layers can be distinguished in the area of the ameloblasts. (Fig. 5, D.) The layer adjacent to the *stratum intermedium* (peripheral layer) consists of fusiform cells and cell débris. The cells are arranged irregularly and are more or less parallel to the tooth surface. The other layer adjacent to the enamel matrix (basal layer) is formed by round or cuboid cells arranged in a continuous row. The third day after injection, the peripheral layer has become reduced in height, whereas the cells of the basal layer have assumed a more nearly cylindrical shape.

It is on the fourth day after the injection that reparative changes in the affected zone can be observed. They seem to start at the incisal border of this zone. The apical portion of the zone of damage shows the inner enamel epithelium arranged in two layers substantially as observed on the second and third day. In the middle portion, the cells of the basal layer (adjacent to the enamel matrix) acquire a more nearly cylindrical shape and some of the nuclei shift peripherally. In the incisal portion (Fig. 5, E), most of the cells already show characteristics of ameloblasts, although their length and number seem markedly reduced.

By the fifth day, the degenerated cells

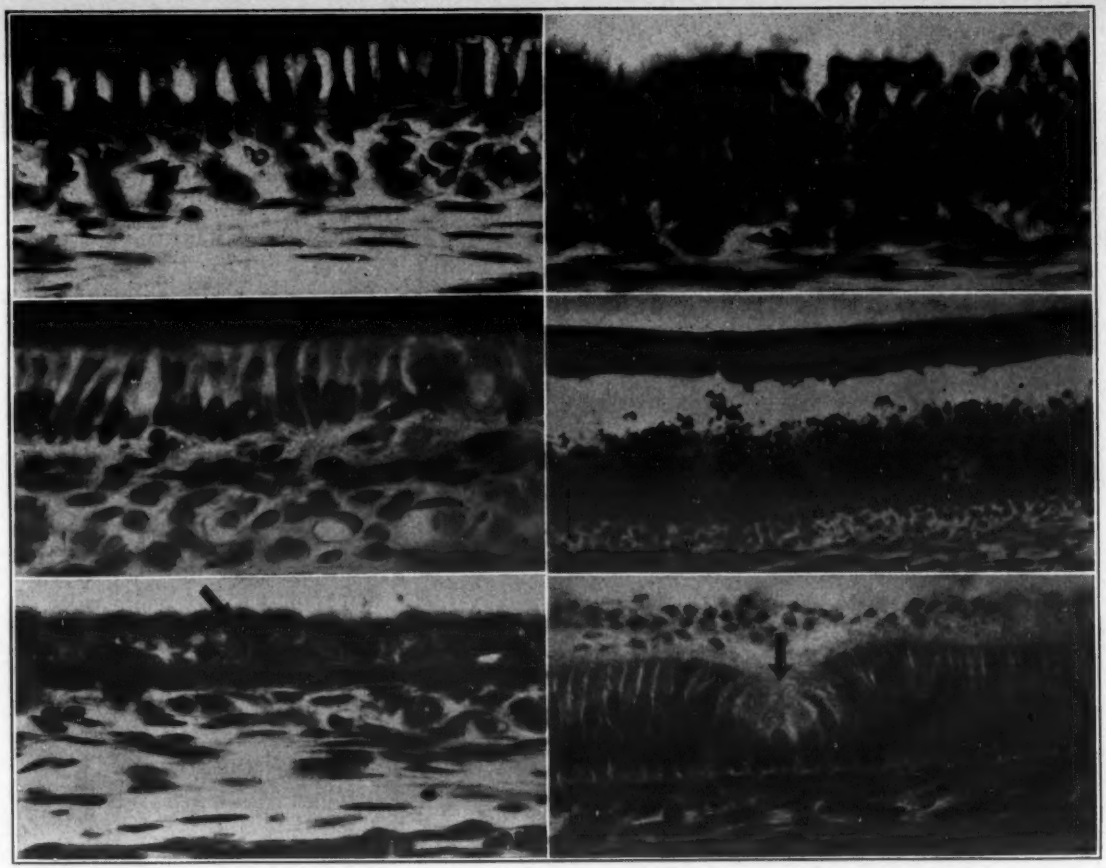

Fig. 5.—Stages in the disorganization and reorganization of ameloblasts. A, focus of disintegration (arrow); shift of nuclei into basal end of ameloblasts. (×750.) B, increase in number of foci. (×350.) C, complete disorientation of ameloblasts. (×860.) D, ameloblasts arranged in two layers, basal cells cuboid (arrow). (×860.) At E, the peripheral cell layer of stage D has almost disappeared. The basal cells are columnar and polarized. (×950.) F, reorganized ameloblasts. (×860.) A, at nineteen hours; B, at twenty-four hours; C, at twenty-eight hours; D, at fifty-two hours; E, at four

of the peripheral layer, adjacent to the *stratum intermedium,* have disappeared and the cells of the basal layer have regained more of the characteristics of ameloblasts. The nuclei have shifted toward the periphery of the cell, which is the normal position. Only occasionally, a nucleus is seen in the portion of the cell toward the enamel matrix. The height of the cell, however, is reduced and the cells are not so densely arranged as normal ameloblasts. (Fig. 5, E.) Exceptionally, the reorganization of the ameloblasts is retarded in the basal and middle zone of the hypoplasia.

From this period on, the structure of the recovered ameloblasts does not change noticeably. The shortness and reduced number of cells remain a characteristic differentiation between the injured and the normal cells of the preexperimental and postexperimental period, even twenty-eight days after injection. In the most apical portion of the hypoplastic area, groups of misshaped ameloblasts are often seen after the longest period of investigation. The misshaped cells, as well as the recovered ameloblasts, contain pigment as soon as they have shifted into the zone of physiologic pigmentation located in the sixth sector.

F. *Changes of the Enamel Epithelium at the Border of the Detached and Attached Enamel Organ.*—When the detachment of the enamel organ in the area of hypoplasia is complete (nineteen hours after injection), the ameloblasts show a characteristic change in their orientation at the incisal border of the detachment. This is the point where the enamel organ is lifted away abruptly from the enamel matrix. (Fig. 6, A.) On the third day after injection, reattachment of the enamel organ has already begun. (Fig. 6, B.) A fold of the ameloblast layer has developed at the incisal border of the hypoplasia area where a sudden change in the orientation of the ameloblast had been observed. The space between the folded ameloblast layer and the surface of the enamel matrix is filled with irregularly arranged cells, which probably are derived from the ameloblast layer. Twenty-four hours later, the original ameloblasts of the fold lose their shape and regularity; whereas the cells close to the enamel matrix have assumed a cylindrical shape and regular arrangement. (Fig. 6, C.) Between these two layers, a small cyst has developed by liquefaction of the central cells. The recovery of the ameloblast layer, at the point of folding, has further progressed after five days. (Fig. 6, D.) At the same time, the cells of the outer layers of the enamel organ have proliferated. These changes are a definite landmark for the incisal border of the area of hypoplasia, and can be observed to the end of the second week after the injection.

Fig. 5.—Stages in the disorganization and reorganization of ameloblasts. A, focus of disintegration (arrow); shift of nuclei into basal end of ameloblasts. (×750.) B, increase in number of foci. (×350.) C, complete disorientation of ameloblasts. (×86o.) D, ameloblasts arranged in two layers, basal cells cuboid (arrow). (×86o.) At E, the peripheral cell layer of stage D has almost disappeared. The basal cells are columnar and polarized. (×950.) F, reorganized ameloblasts. (×86o.) A, at nineteen hours; B, at twenty-four hours; C, at twenty-eight hours; D, at fifty-two hours; E, at four

DISCUSSION

A single injection of strontium chloride solution acts as an acute shock, the effect of which wears off after a short time. The damaged enamel organ is thus given a chance for recovery, if recovery is possible at all.

The earliest pathologic change in the enamel organ of white rats can be observed three hours after a single injection of strontium chloride solution. At the apical border of the fourth sector, a detachment of the enamel organ from the enamel matrix starts, gradually increasing up to twenty-four hours after injection.

The outstanding characteristic of the detachment is its restriction to the fourth sector. It is in this sector exclusively that enamel matrix is being formed. The connection between ameloblasts and enamel matrix is maintained by the newly formed Tomes' processes. This zone can be regarded as the *locus minoris resistentiae* to any injury which affects the enamel organ. The space between the enamel matrix and the detached enamel organ contains a varied amount of fluid, secretion granules and cell débris. It

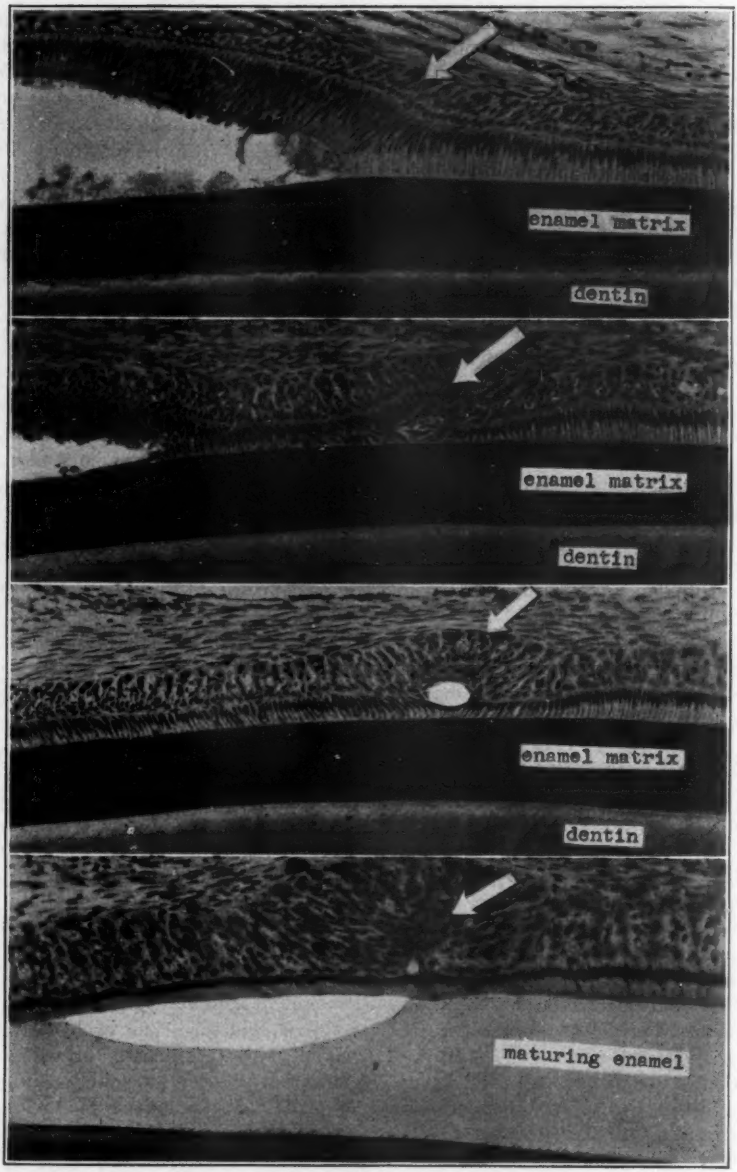

Fig. 6.—Changes at junction of detached and attached enamel organ marking incisal borderline of hypoplasia (arrow). A (nineteen hours), abrupt change in direction of detached ameloblasts. B (fifty-two hours), formation of fold in ameloblast layer at former border of detachment. C (three days), cyst between regenerated ameloblasts and degenerating cells of fold. D (ten days), cyst and hypertrophy of outer layers of enamel organ. (×215.)

seems reasonable to assume that the detachment is caused by the accumulation of fluid between the enamel matrix and the ameloblasts. The accumulation of fluid underneath the enamel organ causes a compression of the periodontal tissues and its blood vessels in the area of detachment.

On the second day, after a single injection of strontium chloride, repair of the detachment sets in. The enamel organ is gradually reattached to the surface of the hypoplastic enamel. Reattachment starts from the incisal border of the area of hypoplasia, progressing to the apical border, and is completed around the fifth day. At the incisal border of the afflicted zone, a fold appears in the enamel organ, which later gives rise to the development of a small cyst.

The reattachment is primarily due to a resorption of the fluid between the enamel organ and the enamel matrix and the pressure of the periodontal tissues. The enamel organ is stretched by the detachment. Reattachment is then impossible without the formation of a fold in the enamel organ. In later stages, the reattached enamel organ regains organic connection with the matrix underlying the hypoplastic area. The nature of the organic reattachment is not yet clear.

The term "ablatio" is suggested for the detachment to indicate that the detachment is not an artefact.

Whereas the ablatio of the enamel organ is evident three hours after injection, the earliest visible changes in the ameloblast layer are observed after fourteen hours. Strontium chloride injection affects only those ameloblasts which, at the time of injection, produce enamel matrix (sector four) (Table 2). The *stratum intermedium* and outer enamel epithelial cells show pathologic changes of a slighter degree and at a later period.

The visible damage on the ameloblast layer appears first in restricted foci in sector four. Later, the changes spread over the entire extent of the hypoplasia. The high columnar ameloblasts, regularly arranged, lose their shape, their polarity and all the characteristics of a highly differentiated epithelial cell Many of the cells are eliminated by necrosis. At the peak of the degenerative changes, the ameloblast layer is replaced by a stratified irregular epithelium. The cells are multiform; cuboid, fusiform, polygonal and star-shaped cells being mingled.

About the third day after injection of strontium, reparative changes begin. The first sign of repair is the arrangement of irregularly and loosely connected cells into two layers. The basal layer is formed of cuboid cells; the peripheral layer of spindle-shaped cells. While the cells of the peripheral layer degenerate farther and finally disappear, the cells of the basal layer gain in height. After a short time, these cells show the characteristics of young ameloblasts, being columnar, with the nucleus situated in the peripheral part of the cell, and arrangement regular.

However, the recovered ameloblasts do not resume their function of formation and calcification of the enamel matrix. The fact that, after recovery, the ameloblasts do not produce new enamel matrix may be due partly to their short life span in the fast erupting rat incisor. It is possible that teeth with a lower rate of eruption than that of the rat incisor would present a different picture.

It has been pointed out that the hypoplastic enamel remains in a state of insolubility, and does not mature. This tends to show that not only matrix formation, but also maturation of the enamel, is dependent on the normal function of the ameloblasts. This interpretation is in agreement with the observation of Chase[13] on hypoplasia due to vitamin B_6 deficiency, traumatization of the enamel organ and fluorine intoxication.

Although the reorganized cells of the

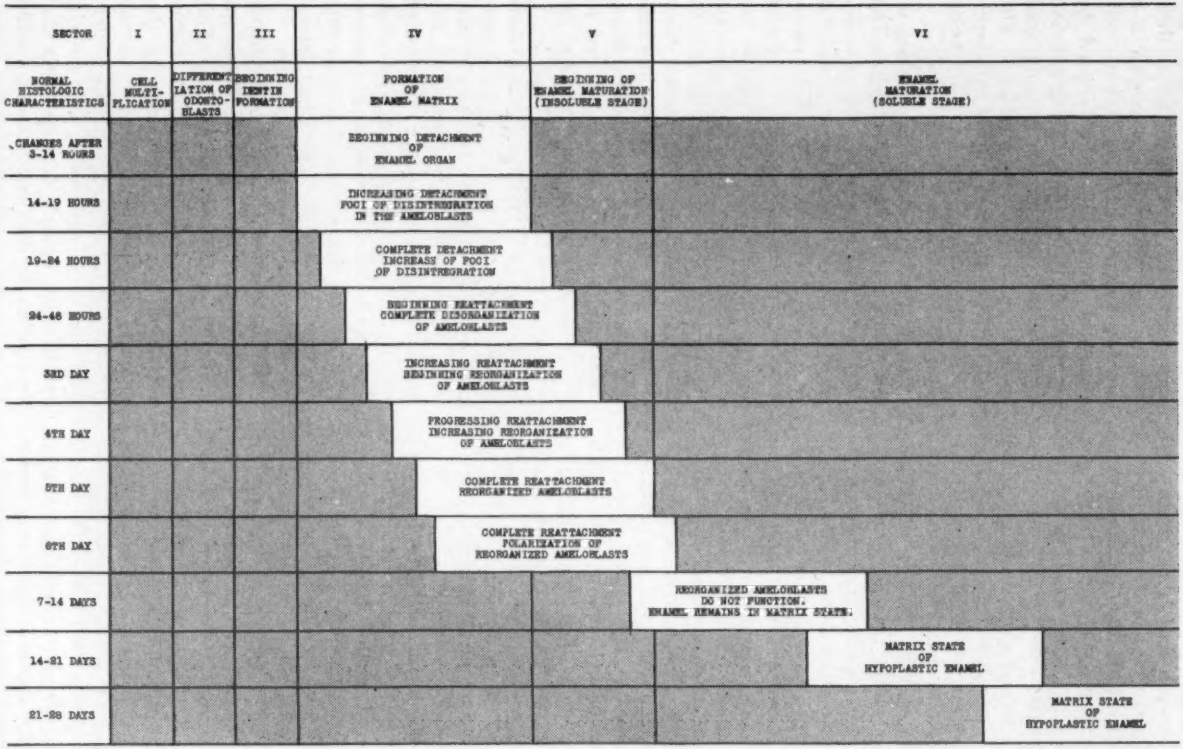

Fig. 7.—Shift of enamel hypoplasia from sector four into sectors five and six and changes in enamel organ from three hours to twenty-eight days after single injections of 1 cc. of 20 per cent solution of strontium chloride. (The gray areas are the normal sectors of the rat incisor.)

inner layer of the enamel organ do not resume the formation of enamel matrix, it is justifiable to designate these cells as ameloblasts. The term "ameloblasts" is, in normal development, used to denote the functional potentialities of the cells of the inner enamel epithelium even before the cells actually start to produce the enamel.

The process of partial recovery and reorganization of the ameloblasts can be classified as regeneration. This is in accordance with the well-known fact that regeneration of highly differentiated tissues and organs is rarely complete.

SUMMARY AND CONCLUSIONS

The effects of strontium chloride injection on the amelogenesis of the rat incisor was studied in thirty-eight animals from 6 to 13 weeks old. The animals were given a single subcutaneous injection of strontium chloride solution in a dosage varying from 700 to 4,000 mg. per kilogram of body weight. Injection of strontium chloride solution in a dosage of over 700 mg. per kilogram of body weight causes severe changes in the dentin and hypoplastic defects of the enamel. In the present paper, only the changes in the enamel and the enamel organ are considered.

The changes are localized to the area on the rat incisor where formation of enamel is in progress at the time of injection. The chronologic sequence of the changes (Fig. 7) are: ablatio of the enamel organ, disorganization of the ameloblastic layer and slight morphologic changes in the *stratum intermedium* and outer enamel epithelium. On the second day, reparative changes set in. The ablatio disappears first, on reattachment of the enamel organ to the hypoplastic enamel matrix. Later, the disorganized and degenerated ameloblasts reorganize and redifferentiate to a certain degree. The recovered ameloblasts do not resume enamel matrix production and the hypoplastic enamel matrix does not undergo maturation.

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(Twenty-eight days after single injections of 1 cc. of 20 per cent solution of strontium chloride. (The gray areas are the normal sectors of the rat incisor.)

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THE RÔLE OF A NEW VITAMIN-LIKE ACTIVATOR IN THE CONTROL OF DENTAL CARIES

WESTON A. PRICE, D.D.S., M.S., Cleveland, Ohio

INTRODUCTION

THE seriousness of the dental caries problem in relation to both human progress and the dilemma of modern physical degeneration emphasizes the need of a bird's-eye view of the problems involved in restoring to man his original immunity.

For the entire period of human life on the earth, say one million years, some human skeletons have been preserved in burials. A study of these remains reveals that there has been more dental caries in the last hundred years than at any time previously and probably more than during any thousand-year period of his history. This situation suggests, if it does not demand, that we analyze critically the changes in man's environment and his interference with it.

As to our present knowledge of the problem, we find it evaluated in the recently published summary made by the Research Commission of the American Dental Association. Two hundred thirty-seven investigators and observers present their best judgment and experience in 276 pages. In this detailed report, we see that there is no recognized theory regarding the etiology of dental caries and no accepted program for the control of the disease. So far as progress is concerned, there is much evidence that, in general, the situation is getting worse from decade to decade.

While outstanding progress has been made in the knowledge of disease in general—knowledge that places great emphasis on the rôle of nutrition in modern degeneration—that splendid progress has revealed the nature and rôle of many of its new factors, especially vitamins. It is profoundly significant, however, that no single vitamin or combination of vitamins has completely solved the riddle of dental caries or pointed the way to a determination of its etiology. This suggests our ignorance as regards any specific

substance for use in controlling dental caries. There must be some food substance that is not adequately provided in modern nutrition, perhaps owing to some fundamental change in quality, preparation or selection of the substance. To judge from the skeletal remains, people of the past obtained a substance that modern generations do not have. The present report will present evidence of a heretofore not generally recognized activating substance. It is not one of the recognized vitamins, but is a substance which belongs in the fat-soluble group.

The data to be presented will indicate that: (a) it plays an essential rôle in the maximum utilization of body-building minerals and tissue components; (b) its presence can be demonstrated readily in each the butterfat of the milk of mammals, the eggs of fishes and the organs and fats of animals; (c) it has been found in highest concentration in the milk of the reindeer and in varying amounts in the milk of several species, varying with the nutrition of the animal, and (d) it is synthesized by the mammary glands and plays an important rôle in infant growth and also in reproduction.

EXPERIMENTAL DATA

In 1926, Yoder[1] published a report on the "Relation Between Peroxidation and Antirachitic Vitamins," including a chemical procedure for determining antirachitic potency. When vitamin D was separated from vitamin A, its rôle included the functions of activated ergosterol, which came to be known as vitamin D. While Yoder's peroxidation method was early used as a chemical test for vitamin D, it was later found that it measured a nutritional factor much broader than its antirachitic function.

In my early reports on the vitamin content of dairy products,[2] I used this test as a measure of the vitamin D content. My data revealed that the nutritional factor it represented included aids to mineral utilization, as well as potency for dental caries immunity. I have accordingly used this method for testing the value of foods, particularly dairy products, for potency in controlling dental caries, and of associated health factors.

In my early reports[3] on the levels of this activating substance in butter as measured by the chemical test reported by Yoder, I expressed the values as vitamin D; but, as my studies progressed, it was revealed clearly that the qualities which I was concerned with in butter were not comparable to vitamin D as represented by ergosterol that had been exposed to ultraviolet radiation. Since butter contained definite nutritional qualities not provided in irradiated ergosterol in addition to its antirachitic properties, I accordingly dropped the term vitamin D, as expressed in Yoder's test, and, for want of a better means of identification, used in my records the term activator X.

Since an acceptable chemical test for vitamin A that depended on the action of antimony trichloride in chloroform solution had been developed by Carr and Price,[4] I made an extensive number of studies of the vitamin A and activator X content of a large series of butter samples obtained from many states and provinces and from different countries throughout the world. These studies were related to two other important studies; namely, sunshine curves and mortality data from various districts. These studies, which have now been in progress for fifteen years, include an analysis of more than 20,000 samples of dairy products. In order to establish wide application of the data, samples were received every two to four weeks from several different parts of the world over a period of several years. These included samples from districts of the United States, northwestern Canada, Australia, Brazil and New Zealand.

It was quickly disclosed that neither total hours of sunshine nor temperature was the chief controlling factor. The

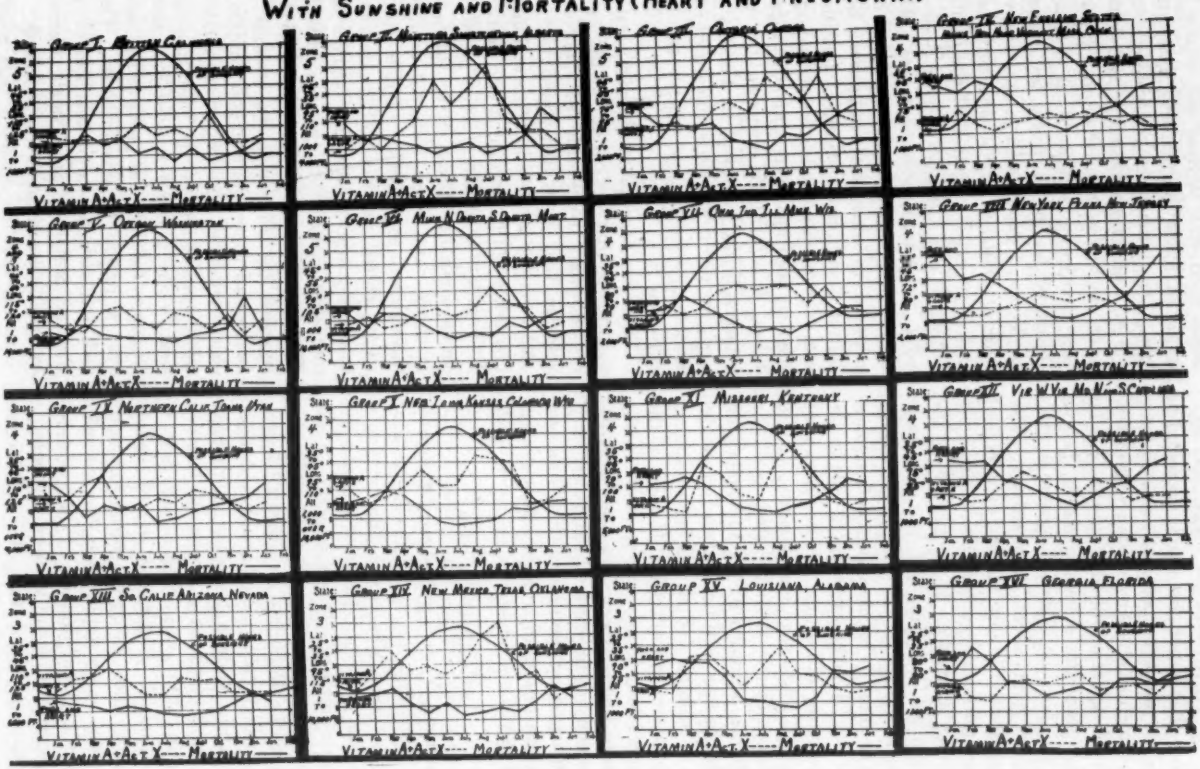
COMPARISON OF VITAMIN A AND ACTIVATOR X CURVES (27-30-31)
WITH SUNSHINE AND MORTALITY (HEART AND PNEUMONIA)
VITAMIN A-ACT X---- MORTALITY

Fig. 1.—Relation by months of possible hours of sunshine to levels of vitamin A and activator X; mortality rates for heart disease and pneumonia. This chart covers certain areas of the United States and Canada in their geographic relationships. Mortality is the phase opposite to the vitamin A and activator X levels.

factor most potent was found to be the pasture fodder of the dairy animals. Rapidly growing grass, green or rapidly dried, was most efficient. It was disclosed that these periods of growth were directly related to the rains and harvest, and, for the southern states, there were two distinct peaks in the vitamin and activator curves, one in the spring and the other in the autumn. In general, in moving northward through the United States and through the Canadian provinces, these two peaks came closer together and the total for the maximum rise was much higher in the northern dairy districts than in the southern. By obtaining samples over a very wide range, curves for vitamin A and aetivator X, as shown combined in Figure 1, were made for the products analyzed from various provinces of the United States and Canada. The total area was divided into sixteen divisions, each representing several thousand square miles.

A study of the data of the health departments of all these districts regarding mortality for heart disease and pneumonia disclosed that the curves were always found to be lowest when the vitamin content of the dairy products was highest. This study is well illustrated in Figure 1, which shows vitamin and sunshine curves for the various latitudes and the mortality curves by months for heart disease and pneumonia combined.

Many facts are revealed in this extensive study. Note, for example, how much higher the vitamin curves are for the north than for the regions farther south; also, how much lower the vitamin curves are in the eastern states and far west where the soil has been tilled the longest. Simultaneously, dairy products were obtained for analysis from several countries in the southern hemisphere, chiefly, Australia, New Zealand and Brazil. These again showed the distinct seasonal variation in vitamin A and activator X content of the dairy products, which were, similarly, in the opposite phase for heart disease and pneumonia. The curves, however, for the southern hemisphere were in the phase opposite to those of the northern hemisphere, but were parallel with the seasons.

As these data were developed, preliminary reports were made from time to time in current scientific journals. These reports are summarized in the bibliography. While it is clearly not possible to review the steps of progress in detail in this communication, certain essential facts are presented briefly, with illustrations. I have been deeply indebted to national, state and provincial officials, also to individuals in the United States, Canada, Australia and New Zealand, for continuous cooperation extending over several years. This assistance has made it possible to develop curves showing comparative values from month to month and from year to year.

In the early part of this work, progress was slow in the differentiation of those activating substances that were identified as vitamins and given alphabetical numbers. Little was known of their nutritional properties. It was early discovered in the history of mineral utilization that one of the most striking manifestations was involved in rickets; and since the therapeutic use of ergosterol that had been exposed to ultraviolet radiation resulted in rapid healing of rickets, being comparable to exposure of the individual to sunlight or suitable artificial radiation, that substance was given the identifying name of vitamin D and was assumed to have the total responsibility for mineral utilization in bone and tooth formation and maintenance. The substance was given the name of viosterol in the United States. It did not prove efficient, however, in the control of dental caries.

Much progress has been made in recent years in identifying four different vitamin D factors, of which viosterol or irradiated ergosterol is vitamin D.[2] Vitamin D^3 is produced by the irradiation of a form of cholesterol. It is now recog-

Fig. 1.—Relation by months of possible hours of sunshine to levels of vitamin A and activator X; mortality rates for heart disease and pneumonia. This chart covers certain areas of the United States and Canada in their geographic relationships. Mortality is the phase opposite to the vitamin A and activator X levels.

nized that activated ergosterol D^2 does not represent the factors essential for the utilization of calcium and phosphorus by the human body. Available data indicate that it is not a product of animal bodies. We accordingly are concerned with data that will relate to mineral metabolism in general and dental caries in particular.

I have found in these studies that, in the control of dental caries, while the consumption of whole butter is an aid in mineral metabolism, greater potency may be obtained by melting a high vitamin butter and allowing it to crystallize for twenty-four hours at a temperature of about 70 degrees. It is then centrifuged, and, under the process, it separates into an oil that is limpid at that temperature, with a solid crystalline layer below. This oil is much higher in the activating factor than the whole butter. It is this substance that I shall refer to in this communication, unless otherwise explained, as a source of activator X.

There are many expressions of disturbed mineral metabolism in both the soft and the hard tissues of the body. Those of the skeleton are most easily demonstrated. Rickets in young children and animals is easily demonstrated by the roentgen rays and the progress in its healing is readily measured by this means.

Rats are used largely for testing the efficiency of various treatments for rickets. The effect of administration of activator X on rickets is striking.

In Figure 2 will be seen the roentgenographic appearance of the forelegs and the tails of two rats on the same deficiency diet; namely, Steenbock 2965. It will immediately be seen that all of the bones of No. 1 are very transparent and the carpal bones have not formed. The junction of the epiphyses and the diaphyses of the bones, especially of the tail, is shown to be characterized by a zone of separation. In rat No. 2, there is a marked density of the bones, seen as an area of opacity to the roentgen rays, and the carpal bones are well formed. The head of the humerus and the epiphyseal zones of provisional growth of the tail are well calcified, with only a line

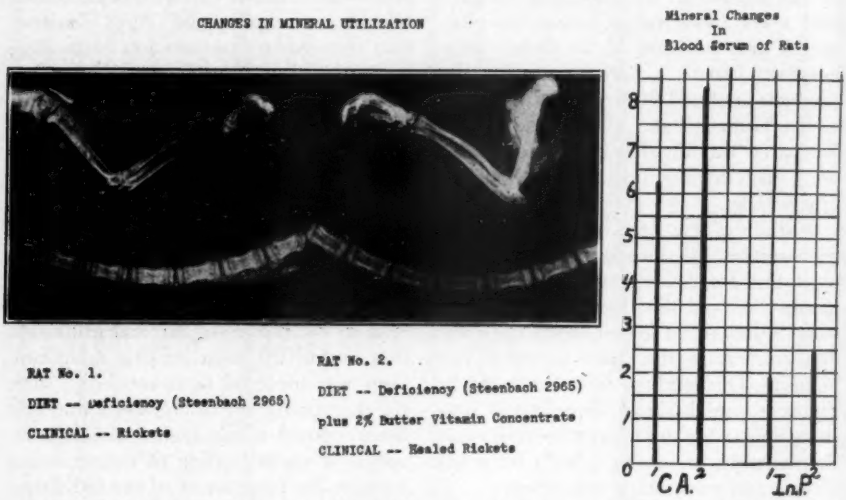

Fig. 2.—Treatment of rickets in rats by adding 2 per cent of butter-oil concentrate containing activator X to deficiency diet. Healing of rickets in the carpal and tail bones of rat No. 2 and improvement in blood minerals are marked.

of separation between them and the diaphyses. This rat received, as an addition to the deficient diet, 2 per cent of the diet as a butter-oil concentrate obtained from a high vitamin butter. Clinically, this condition constitutes healed rickets. The quantity of this butter used would constitute only about one-half ounce for a child eating 2 pounds of food per day. This is a very small quantity for a growing child. To the right in Figure 2 will be seen the mineral levels in the blood serum of these two rats. The calcium for rat No. 1 is at 6.26 mg. per hundred cubic centimeters, and in rat No. 2, it is 8.4. The inorganic phosphorus in rat No. 1 is at 1.93 mg. per hundred cubic centimeters and in rat No. 2, it is 2.5 mg. We see at once that this clinical condition in these two rats is attended by marked correction of the blood chemical levels.

The product that was administered to rat No. 2 is a normal constituent of a normal milk, Nature's only complete diet for mammalian infants and by far the most important single item of food for growing human beings in all periods of stress.

I shall use as illustration of a case profiting by the use of this dietary factor, the case of a boy 3 years of age (Fig. 3) brought to me with a fracture. He was in a cast. Rampant tooth decay was present. The diet had consisted of white bread and skimmed milk, which had been the source of his nutrition for an extended period owing to the poverty of the family at the time of the depression. He had been suffering from convulsions, which had been increasing in severity over a period of eight months. His leg had been broken when he had fallen to the floor in one of his convulsions three

Fig. 3.—Boy who was near death with convulsions caused by lack of calcium in blood. The convulsions had been getting worse for eight months and the fractured femur had been disunited for three months. The patient had been living on white bread and skimmed milk. Convulsions ceased completely and the fracture united when he was on a whole milk, whole-wheat gruel and activator X diet.

months before receiving the reinforced diet. The minister who brought him to me had been called to the home to baptize the boy for burial because he was considered so near death.

The only treatment given was a change in diet from skimmed milk and white bread to whole milk and a gruel made of freshly ground whole wheat. Over this gruel was poured about a dessert spoonful of butter oil from a sample of butter that had been produced when the cows were eating rapidly growing green wheat. After his first meal, the boy slept his first night without a convulsion. He was fed five times the next day on the same diet, and had no convulsions. Recovery was very rapid.

Figure 3 shows the broken leg before and after the use of the reinforced diet for one month. The x-ray film shows the healed fracture. The patient had been taken out of the cast the day before. The x-ray film of the broken femur shows clearly the healing of the fracture. The photograph is indicative of the excellent physical condition of the child. Without operation on his teeth, dental caries was controlled. He grew to be an athletic young man, active in sports, particularly baseball.

During the severe industrial depression, rampant caries developed in a great number of cases in the families of mill workers. Children in these families provided excellent clinical material. A typical result of work done for these families is shown in a study of an experimental group of twenty-seven mission children selected on the basis of rampant dental caries. At the beginning of the test, in the average chemical analysis of all of the saliva specimens of the group, the inorganic phosphorus had passed from the powdered bone in an amount of 2.4 per cent of the total inorganic phosphorus of the saliva. In two months, this condition changed to a movement toward the powdered bone averaging 3.42 per cent of inorganic phosphorus for the entire group; in four months, to 8.13 per cent; in five months, to 11.36 per cent, and in seven months, to 11.75 per cent.

Since these children were all from poor homes, many of the families being on relief, one extra good meal a day at midday was provided for the entire group at the mission. This was preceded by administration to each child of one teaspoonful of a mixture containing a high vitamin butter oil obtained by centrifuging the butter at 70 degrees from a twenty-four hour crystallization of the melted butter. This butter was selected on the basis of its high content of activator X. It was mixed with equal parts of a high-vitamin, natural cod-liver oil. The clinical effect was apparent complete control of dental caries for the entire group, as shown in the x-ray films. In many of these cases, the open cavities were left without fillings; and, in all such cases, the exposed dentin took on a hard glassy finish. There were many other evidences of betterment.

One of the boys, who was so weak at the beginning of the test that it was considered questionable whether it was safe for him to walk the two blocks from his home to the mission for the one reinforced meal a day, in six weeks was able to play basketball. He was dashing about as a star player, and there was no evidence of undue fatigue on his part in this strenuous game.

Under the stress of the industrial depression, the family dietary for the children in this mission group was very deficient. During the experiment, the home meals were not changed, nor was the home care of the teeth. The preliminary studies of each child included complete x-ray examination of all the teeth, chemical analyses of the saliva, a careful plotting of the position, size and depth of all cavities, a record of the height and weight and a record of school grades, including deportment. It is important to note that the home diet which had been responsible for the tooth

decay, was exceedingly low in body-building and repair material and high in sweets and refined starches. It usually consisted of a highly sweetened coffee and white bread, vegetable fat, pancakes made of a white flour and eaten with syrup and doughnuts fried in vegetable fat.

The diet provided these children in the supplemental meal was as follows: About 4 ounces of tomato juice or orange juice and a teaspoonful of a mixture of equal parts of a very high vitamin, natural cod-liver oil and an especially high vitamin butter was given at the beginning of the meal. The child then received a bowl containing approximately a pint of a very rich vegetable and meat stew, made largely from bone marrow and fine cuts of tender meat. The meat was usually broiled separately to retain its juice and then chopped very fine and added to the bone-marrow meat soup, which always contained finely chopped vegetables and plenty of very yellow carrots. The next course consisted of cooked fruit, with very little sweetening, and rolls made from freshly ground whole wheat and spread with high vitamin butter. The wheat for the rolls was ground fresh every day in a motor-driven coffee mill. Each child was given also 2 glasses of fresh whole milk. The menu was varied from day to day by substituting for the meat stew fish chowder or organs of animals. From time to time, food similar to that eaten by the children was placed in a 2-quart

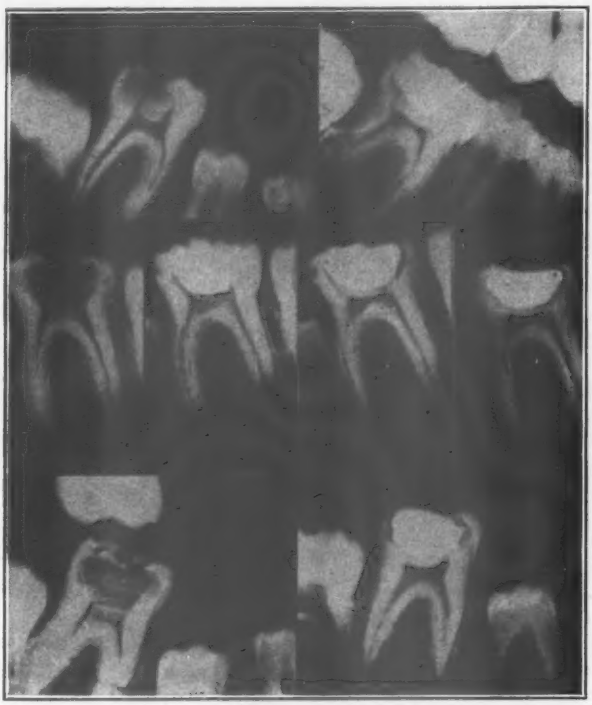

Fig. 4.—Typical deep caries with pulp exposure in cases from mission group. With diet reinforced with activator X, the vital pulps built in secondary dentin covering the exposure area.

jar and brought to the laboratory, where chemical analysis showed that these meals provided approximately 1.48 gm. of calcium and 1.28 gm. of phosphorus in a single helping of each course. Since many of the children took "seconds," their intake of these minerals was much higher. Since the accepted figures for the requirements of the body for calcium and phosphorus are 0.68 gm. of calcium and 1.32 of phosphorus, it is obvious that this one meal a day, plus the other two meals at home, provided a factor of safety. Clinically, this program completely controlled the dental caries of each member of the group, as determined by x-ray and explorer examination.

It is important to note with regard to the effect of the special nutritional program on this group of mission children that two different teachers came to me to inquire as to what had been done to make a particular child change from one of the poorest in the class in capacity to learn to one of the best. Dental caries is only one of the many expressions of our modern deficient nutrition.

An example of the change produced in the structure of the teeth as a result of the reinforced nutrition in this mission group is illustrated in Figure 4, which shows three first permanent molars in which caries apparently had decalcified the dentin to the vicinity of the pulp chamber, causing exposure. The pulps were still vital. It will be noted at the left, in Figure 4, that each of the three molars apparently had an exposure of the pulp. In the views to the right, a progressive filling in of the pulp chambers can be noted from a deposition of secondary dentin, making a roof over the pulp and thereby providing a protection which enabled the pulp to remain vital and useful for an extended period. This is frequently experienced as a result of reinforcing the diet with high-vitamin and high-activator butter, together with reducing the carbohydrate intake to a normal level as supplied by natural foods and by increasing the foods that provide body-building and tooth-forming minerals. The condition that obtains in the tooth is one in which the minerals cease to be taken in minute amounts from the tooth structure and, owing to the change in the saliva, the minerals in ionic form pass from the saliva bathing the tooth cavity into the demineralized dentin, in many cases a hard and even glassy surface resulting.

It is important to keep in mind that silver nitrate will not penetrate appreciably into tooth enamel after the tooth has been erupted for a year or more, in a normal mouth with normal saliva and high immunity to dental caries, though it will penetrate an appreciable distance in a recently extracted tooth in the same mouth. This experiment is easily made with impacted third molars, in which silver nitrate will often penetrate a millimeter into the enamel.

An excellent illustration of the rescue of a large number of apparently doomed teeth in the same mouth is shown in Figure 5. The patient, a girl aged 14, had lost all four of the first permanent molars and the diagnosis made by her local dentist indicated the necessity of removing all of the erupted teeth and the construction of two artificial dentures. Studies indicated that she had forty-two open cavities in twenty-four teeth in addition to fillings. The patient was placed on a reinforced diet including approximately one-half teaspoonful of a mixture of a high vitamin A and high-activator X butter oil mixed with equal parts of a very high-vitamin natural cod-liver oil, taken in capsules three times a day. She was on this regimen for about seven months, with the result that there was very little evidence of extension of the caries, notwithstanding that no fillings were placed, with the exception of two or three temporary ones. The condition of these teeth before the dietary change is shown in the upper two rows of Figure 5.

Because of the extreme severity and extent of the dental operations needed, restoration was not undertaken locally, but the patient was sent to Cleveland from a southern state; also for the management and care of her case. The operative program was completed by my associate Dr. Richard Spayde. The roots of three of the straight-rooted teeth with extensive pulp exposure were filled. Another tooth had had its roots filled before the patient came to me.

This girl, now 15, has all her teeth with the exception of the four first permanent molars extracted earlier in life. The teeth have been well restored with good masticating surfaces and the appearance of the patient is excellent. She is so enthusiastic that she wishes to give lectures on nutrition to aid others with their dental problems. Important light is thrown on this case by both the chemical analysis of the saliva and the bacterial count. The inorganic phosphorus of the

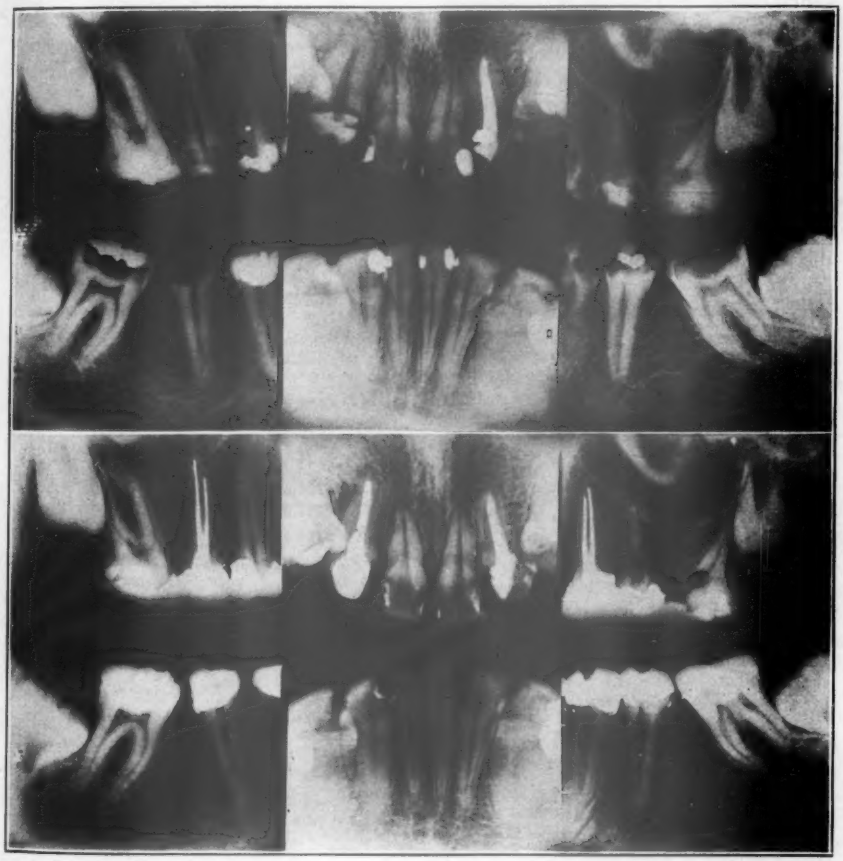

Fig. 5.—Case of girl who had forty-two cavities in twenty-four teeth. With the diet reinforced with activator X, the pulp chambers built in secondary dentin and all the teeth were saved. Full dentures had been recommended.

saliva, shaken with powdered bone, was changed from +19.1 to −29.5. The bacterial count change for *L. acidophilous* was from 680,000 to none.

This form of nutritional control of dental caries is so satisfactory that I can recommend it with confidence as adequate to control well over 95 per cent of dental caries, in the hands of painstaking, efficient and informed dentists.

During the years that these investigations on the nature and source of this special activating substance in butter, which I have called activator X, have been in progress, no reports have been noted from other workers of its discovery until the last few years. Then Schantz, Elvehjem and Hart[5] reported the comparative nutritive value of butter fat and certain vegetable oils. Their data were summarized in *Dairy Council Digest,* March 1940, as follows:

A series of feeding experiments on rats showed differences in the nutritive value of common fats. The rats which received butter fat grew better than the rats fed vegetable oils, were better in appearance, and had better reproductive capacity. Apparently butter fat contains a substance not present in the other fats tested, which is essential for the growth and health of young animals. This difference is not due to vitamins A, D, or E, but to a difference in the chemical constitution of the fats. These findings are significant to the knowledge of nutrition because they indicate additional reasons why milk fat has superior value for human diets.

Hart emphasizes the importance of these findings. He says:

Milk is indispensable for the best nutrition of children and serves as a concentrated protective source of nutritional essentials for all ages. This being true, dairying must continue as a part of our agriculture if our standards of living are to be maintained. A people without milk and in general the means to make a better milk, must suffer from high infant mortality, poor child nutrition, and forego the liberal use of a product so nearly complete in all nutritional factors. Milk is the one food with a liberal concentration of all the nutrients, except a small number of minerals, that can claim the distinction of protecting against deficiency diets. It can be improved by better feeding. But the mammary gland in its distinctive synthetic capacity and as a concentrator elaborates a commercial and readily available product for which there is no equally effective substitute.

Another group of workers using calves as the experimental animals has recently reported a similar superiority of butterfat in feeding trials. T. W. Gullickson, F. C. Fountaine and J. B. Fitch,[6] of the Division of Dairy Husbandry, University of Minnesota, used animal and vegetable fats with skimmed milk, with the following results:

TABLE 1.—RELATION OF ACTIVATOR X TO VITAMIN A AND BUTTER FAT STRUCTURE*

Date 1942	Saponification Number	Iodine Number	Vitamins A	Vitamins Int. Units	Activator X
2/23	188.0	25.0	0.10	95	0.1
3/4	185.5	31.9	2.2	2,000	18.0
3/16	190.0	32.0	2.2	2,000	18.0
4/2	225.0	33.0	4.5	4,300	32.0
4/8	223.0	33.0	5.5	5,200	32.0
4/13	234.0	35.0	5.5	5,200	26.0

*Data on six ten-day samples of cream from same herd, near Hereford, Texas, showing marked increase in both nutritional factor reported by Wisconsin group and activator X factor, strongly indicating that they are the same.

Feeding tests were conducted to compare the feeding value of the following fats and oils for calves: butterfat, lard, tallow, coconut oil, peanut oil, corn oil, cottonseed oil, and soybean oil. . . . In average daily gain in weight as well as in general well-being, the calves fed butterfat excelled those in all other groups. Following closely were those receiving lard and tallow. Corn oil, cottonseed oil and soybean oil were the least satisfactory. . . . They appeared unthrifty, listless and emaciated. Some calves in these groups died and others were saved only by changing to whole milk.

We are concerned to note the probable

relationship between the factor that has been disclosed by the Wisconsin and Minnesota groups and activator X and vitamin A. Table 1 shows the relation of activator X and vitamin A to butterfat structure as reported by the Wisconsin Group, which shows the comparative readings in six spaced samples of butter produced by the same cows. This herd was fed in Deaf Smith County of northwest Texas near Hereford. The samples were obtained about ten days apart, beginning with February and extending through to April. In March, the fodder was reinforced with green alfalfa hay.

It will be noted that all of the factors, namely the saponification number, iodine number, vitamin A and activator X, progressed through a wide range and are in general parallel. The addition of the green pasture also produced a marked change in the color of the butterfat. The first two samples of butter, when separated from the cream, were as white as lard. A very slight tint was showing in the third sample, which increased progressively to a brilliant golden yellow through the next three samples. The relation of the changes in these four factors to each other and to the green pasture addition to their fodder is shown graphically in Figure 6, which also shows a change in the color of the butter as photographed on orthochromatic plates. It will be noted that the evidence is very striking in that the factor which I have been studying and referring to as activator X is probably the same factor that has recently been observed and reported by both the Wisconsin and the Minnesota groups.

It is important that we observe the effect of the administration of the activator X factor to patients suffering with rampant dental caries on each the incidence of caries, the change in chemical analysis of the saliva and *L. acidophilous* growth. I have previously reported that in the inorganic phosphorus of the saliva, as determined by an adaptation of the Kuttner and Cohen[7] technic for blood, in which the proteins of the saliva are precipitated by sodium acid molybdate and trichloracetic acid, there is a marked change in the behavior of the phosphate ions of the saliva when it is shaken with powdered bone or powdered tooth substance. In the mouths of susceptible individuals, the inorganic phosphorus is increased by transfer of the phosphate ions from the powdered bone or tooth chips, whereas, in normal saliva of patients with immunity to dental caries, the movement is from the saliva to the negative adsorbent; namely, powdered bone or tooth chips. This is graphically shown in Figure 7 for a group of six typical cases.

In this group, the saliva, before the treatment began, gained 11.5 per cent in inorganic phosphorus; whereas, after treatment, the saliva lost 13.9 per cent of its inorganic phosphorus. The change in nutrition included an increase in the activator X and vitamin A content as concentrated from a high vitamin butter and a reduction in carbohydrates; also an increase in mineral-providing foods. Before the change in nutrition, when the tooth decay was considered active, *L. acidophilous* averaged, for the group, 323,000 colonies per cubic centimeter of saliva, and, after treatment, averaged 15,000. These data are typical of many hundreds of clinical cases in which dental caries has been reduced apparently to zero, as indicated by both x-ray and instrumental examination.

We human beings of modern civilization are at a great disadvantage in the selection of foods in that we seem to have largely lost a sixth sense by which we would recognize a specific need for special food. Many of the primitive races and most animals retain the capacity to satisfy the body needs by choosing the foods that will provide minerals and vitamins. This is well illustrated in one of my experiments with chickens.

Three brooders, each carrying twenty-five chickens, 3 days old, were provided with a diet of grain. No opportunity was given the chicks to supplement the diet, as chickens in the open or birds in the wild can supplement theirs by picking up green food and insects. In order to provide an additional source of food, each brooder was supplied with a measured quantity of butter selected on the basis of its vitamin A and activator X content.

Brooder No. 1 had a butter that was high in both vitamin A and activator X; brooder No. 2, a butter high in vitamin A and low in activator X, and brooder No. 3, a butter low in both vitamin A and activator X. It was observed that the chicks in brooder No. 1 developed much better than those in either of the two other brooders even though the vitamin A content was high in both brooder No. 1 and brooder No. 2. An important part of the experiment was observation of the effect of these diets on the chemical content of the blood. On the eighth day, a sufficient number of chickens were killed for blood tests to determine the level of the product of serum calcium and serum inorganic phosphorus.

A product of 40 is considered normal for most species. At the beginning of the

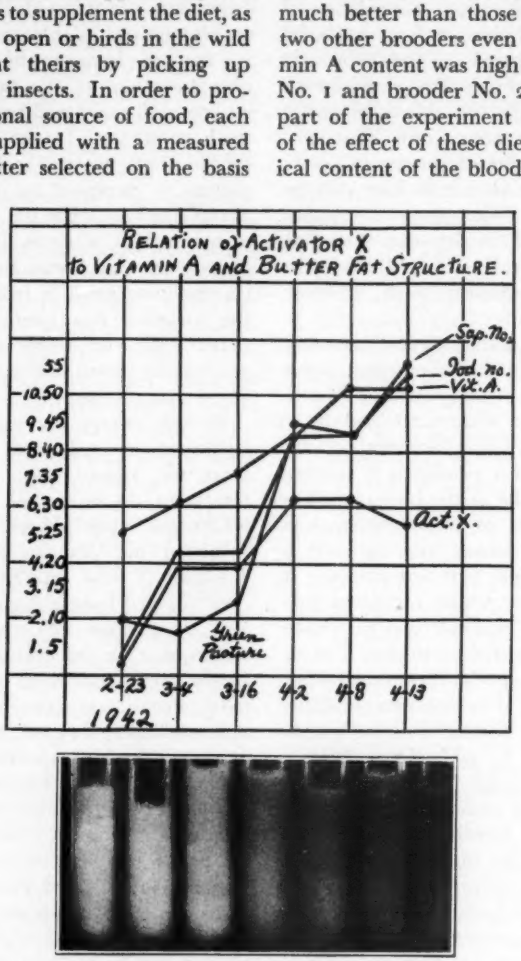

Fig. 6.—Above: Four butter factors, saponification number, iodine number, vitamin A and activator X graphically shown. There was a rapid rise of all when green pasturage was added. Below: Difference in natural color of butters.

test, this factor stood at 29.7. On the eighth day, for the chickens receiving the butter high in both vitamin A and activator X, this factor had increased to 31.2; for the chicks in brooder No. 2, receiving the butter high in vitamin A and low in activator X, it decreased to 28.8, and for those in brooder No. 3, receiving the butter low in both vitamin A and activator X, it had fallen to 17.8. On the twentieth day, this progressive change was even more marked, being at 32 for the chicks receiving butter high in both vitamin A and activator X and at 25 for those receiving butter high in vitamin A and low in activator X. For those receiving butter low in both vitamin A and activator X, this product of serum calcium and serum inorganic phosphorus had fallen to 13. This result is strikingly illustrated in Figure 8.

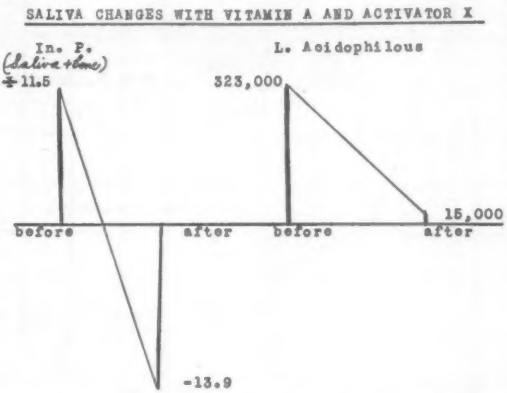

Fig. 7.—Six typical cases in which, under influence of reinforced diet, inorganic phosphorus factor changed from average of +11.5 to −13.9 and L. acidophilous count fell from 323,000 to 15,000.

The significance of these data is very great since they throw an important light on the lowering of the level of defense for many of our modern degenerative processes, including dental caries.

An important observation was made with regard to the behavior of the chicks in these three groups, particularly as to the amount of the butter they consumed and the effect on their general health. It was noted that the chicks in pen No. 1 ate much more butter than those in either pen No. 2 or pen No. 3. This suggested the desirability of making an observation of the ability of the chickens to select from three samples of food the one that was highest in vitamin A and activator X. Accordingly, a new group of forty chickens was started in a large brooder. The same deficient diet was used and three containers supplying the same three grades of butter were placed in the large brooder, fresh each day. The butter was weighed before and after each feeding and the containers were shifted to different parts of the brooder so that the same grade of butter was not in the same place twice in succession. This was repeated for fifty-seven days, when it was found that the chickens selected and ate about two and one-half times as much of the high activator X butter as of the low. I could not distinguish between these butters, nor could any member of my staff. This clearly indicated an ability on the part of the chicks to select the best food.

An important modification of this chick experiment related to the capacity

of this butter vitamin and activator to maintain life. The same three grades of butter were used and the chicks were on McCollum's deficiency diet 3142. When 28 per cent of the chicks had died in the pen with the low vitamin A and low activator X butter, only 16 per cent had died in the group receiving butter high in vitamin A and low in activator X, and none had died in the pen with the butter high in both vitamin A and activator X. When 72 per cent of the chicks were dead in group 3, 53 per cent were dead in group 2 and only 24 per cent in group 1.

It has generally been assumed that cod-liver oil is an adequate source of the fat-soluble vitamins, but that this is not true for human beings, animals or birds is readily illustrated by the following experiment in which turkeys were used that were afflicted with weak legs. Three groups of turkeys were used. Those in pen No. 1 were controls; those in pen No. 2 received cod-liver oil in addition to the stock food on which they were being fed, and those in pen No. 3 received in addition to foods mentioned butter high in vitamin A and activator X. After a seven-day period, the controls had gained only 8.3 per cent in weight and those in pen No. 2, on cod-liver oil as an addition to the stock food, had gained 16.7 per cent; while those in pen No. 3, receiving in addition the high vitamin A and activator X butter, gained 37.5 per cent in weight, more than twice the gain of those in pen No. 2 and more than four times that of the controls in pen No. 1. The difference in their appearance and condition is shown in Figure 10. We are concerned to note the changes in the blood. The calcium and phosphorus increase is shown graphically at the right in Figure 9. The calcium increased 2 mg. in groups 2 and 3, the phosphorus, 1 mg. in group 3.

Space does not permit a detailed presentation of my experimental studies showing the direct relationships among

BLOOD CHANGES IN CHICKS WITH THREE GRADES OF BUTTER.

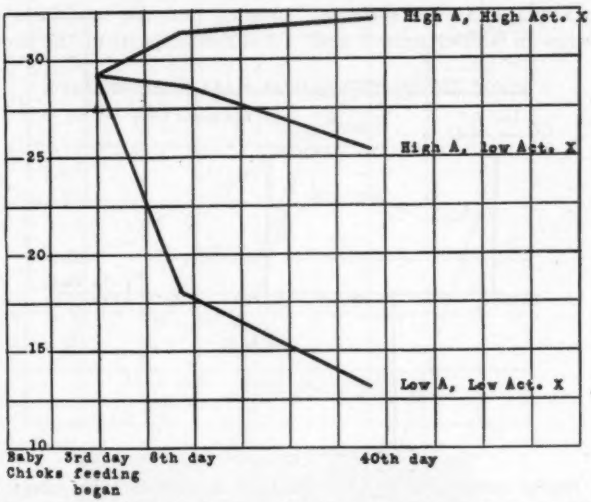

Fig. 8.—Changes in blood of chicks depending on vitamin A and activator X content. The product of serum calcium and serum inorganic phosphorus went up when both were used and fell to a low level when butter with low vitamin A and activator X content was used.

the soil, chemical content, the plants produced by the soil and the effect of those foods on human beings and animals.[5]

DISCUSSION

Interpretation of these data in relation to current thought regarding the etiology and control of dental caries requires strong emphasis on the need for a broader view than is involved in the interpretation that dental caries is purely a local problem in the mouth and solely due to the presence and activity of aciduric organisms propagated by favorable pabulum supplied in the food and chiefly by sugar. It is also strongly indicated that we must not think of dental caries in terms of oral hygiene, as important as that process is.

My studies of fourteen primitive racial stocks in various parts of the world, selected on the basis of their unique physical environment, have shown that where isolated and dependent on their native foods, selected in accordance with the accumulated wisdom of the racial stock, people are relatively free from dental caries. This was true notwithstanding the fact that almost no effort was made at oral hygiene. At their point of contact with the foods of modern civilization, they rapidly lost their immunity, in large part because of the high sugar and refined starch content, which provided pabulum. However, many other expressions of degeneration appeared besides dental caries. The percentages of teeth attacked by dental caries in these

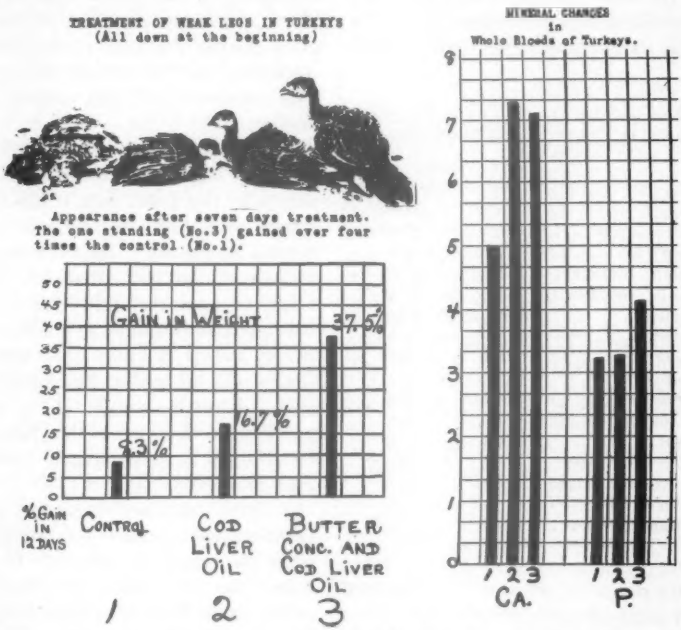

Fig. 9.—Young turkeys which, when fed on stock food, rapidly developed weak legs. They recovered much more rapidly with activator X and cod liver oil than with cod liver oil alone, as shown in the photograph. The gain in weight was twice as great in seven days as were the gains in the cod liver oil group and four times as great as that of the control group. The graph shows the changes in amounts of calcium and phosphorus.

groups, the more isolated as compared with the modernized, are shown in Table 2.

On the basis of the chemical analysis of the foods, it was disclosed that the primitive diets of these various groups in various environments all indicated a high content of minerals and vitamins, including activator X. I have reported these data in several communications.[9]

Table 1 and Figure 6, above, show the chemical characteristics of butters produced in Deaf Smith County, Texas. Much publicity has been given to the observation that dental caries had a much lower incidence in the town of Hereford than in most other districts in the United States. It is of special interest that during the years that I have been obtaining butter samples from various parts of the United States and Canada and several other countries, I have been making a special study of the dairy products in the immediate district of northwest Texas and eastern New Mexico in the adjoining counties of Curry, New Mexico and Deaf Smith County, Texas. On the basis of the samples of butter received from these counties and analyzed, during the past twelve years, I have had butter shipped to Cleveland because of its very high content of activator X and vitamin A to use in my experimental groups of human beings and animals and have found its use highly effective in the control of human dental caries, when accompanied by an adequately adjusted food intake. During these years, it has been found that the high level of activator X and vitamin A was directly associated with the specially favorable pasturage, chiefly wheat grass and other cereal grasses and alfalfa in a lush green state of growth. The cows were pastured on this wheat grass during the fall, winter and spring until time for the wheat plants to stalk. The winter wheat was usually sown in August.

TABLE 2.—PERCENTAGES OF TEETH ATTACKED BY CARIES IN PRIMITIVE AND MODERNIZED GROUPS

	Primitive	Modernized
Swiss	4.60	29.8
Gaelics	1.20	30.0
Eskimos	0.09	13.0
Northern Indians	0.16	21.5
Seminole Indians	4.00	40.0
Melanesians	0.38	29.0
Polynesians	0.32	21.9
Africans	0.20	6.8
Australian Aborigines	0.00	70.9
New Zealand Maori	0.01	55.3
Malays	0.09	20.6
Coastal Peruvians	0.04	40.0+
High Andes Indians	0.00	40.0+
Amazon Jungle Indians	0.00	40.0+

In the immediate districts in which the specially high vitamin butter was produced by this pasturage, it has now been shown that the butter content is directly related to the soil. Excavations to trace the wheat roots show that they pass down 6 feet or more through 3 feet of top soil, varying in depth, into a caliche soil which is very rich in calcium. This caliche consists of glacial pebbles cemented together with calcium carbonate. All of the plants growing on these areas that have this soil foundation are particularly rich in minerals and vitamins.

I have obtained samples of wheat from thirteen districts surrounding Hereford for chemical analysis. It is of interest that while these samples all show a relatively high level of thiamine, vitamin B^1, there is still a marked variation which is not related directly to the protein, calcium or phosphorus content.

Farm stock produced in this area has a much higher market value and a greater capacity for reproduction than the stock in most states. The capacity of most of our states for supporting domestic animals has progressively decreased until, in many districts, the capacity of the farms has gone down to about 50 per cent. When animal life degenerates because of inadequate food,

human beings react similarly. The data disclose a physical basis for our modern physical degeneration including dental caries.

SUMMARY

1. Data have been presented revealing a wide range of nutritive factors, one of which has not been generally recognized and to which, for want of an accepted identification, I have referred as activator X. This is found in the food fats of animal origin and is particularly high in butterfat when the dairy animals are eating lush green pasturage directly or rapidly cured and stored for stall feeding.

2. Data have been presented indicating that this factor, activator X, plays an important rôle in such vital processes as the control of dental caries and the healing of fractured bones.

3. It has been shown that dairy products in Hereford vicinity may vary through a range of fiftyfold in a few weeks' time in the vitamin A and activator X content, the range depending directly on the fodder. There is a sharp rise at the time that the green pasturage is added to the ration of the cows.

4. This factor, which I have discovered in my investigations of butterfats, gives strong evidence of being the same factor that has recently been announced by the Dairy Department of the University of Wisconsin and of the University of Minnesota, which they identify by determining the saponification number and iodine number and animal feeding.

5. The addition of butter high in activator X to the diets of human beings suffering from tooth decay causes a marked change in the chemical constituents of the saliva and the growth of *L. acidophilous*.

6. Data have been presented indicating that chickens have the ability to recognize and select butters high in activator X and that this prolongs their life.

7. Turkeys are shown to grow much more rapidly when this factor is available in their food than when cod-liver oil alone is used, and its addition to their diet prevents and cures weak legs.

8. Clinically, the use of butter high in activator X, in conjunction with a favorable selection of natural foods, as shown through a period of seventeen years, is highly effective in the control of dental caries.

9. Primitive races controlled dental caries with diets high in body building factors which included activator X.

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8926 Euclid Avenue.

COMBINED INTRA-ORAL AND DENTAL FIXATION IN FRACTURE OF THE MANDIBULAR ANGLE WITH CONSIDERABLE DISPLACEMENT

ERWIN W. FERBER,* D.D.S., M.S., San Francisco, Calif.

A MODIFICATION and simplification of an intra-oral sectional splint suitable for reduction of fracture involving the angle of the mandible and having an edentulous posterior fragment is here described. The method assures simplicity of procedure not only for the operator, but also for the patient.

The principles of treatment of all fractures are: (1) reduction and (2) retention of the fragments until satisfactory union has been accomplished.

Many procedures for reduction and retention are being employed by oral and plastic surgeons, each having its advantages and indications for obtaining the desired end-result.

1. The method of reduction by external fixation on the principle of the Roger Anderson method of fracture fixation by pins connected with an adjustable external locking unit or Waldron's modification of the Roger Anderson splint.

2. The Kirshner wire method.

3. Implantation of vitallium screws with complete assemblage of rod and tie wire placed intra-orally; the use of Haynes-Griffin skeletal splint.

4. Darcissac method, exerting traction on a wire placed through the angle of the mandible and based on a plaster headcap. (Elastic traction may be used if complete reduction cannot be immediately accomplished.)

5. The use of various intra-oral appliances: (a) Forked wire lever based on a capped splint in the lower molar region or on an upper crown, or a jack screw fastened to an upper splint; the teeth in the latter method being either semi-immobilized or completely so. (b) Intra-oral splints with attached pressure pads.

6. Open reduction with bone suture or Lane plate.

7. Extra-oral circumferential wiring of bone fragments.

This paper was not written with the intention of criticizing other methods, but rather to present a modification of a method originated by Col. Roy A. Stout, of the Dental Staff at Walter Reed Hospital, Washington, D. C.

The men responsible for the modification and simplification of an already satisfactory sectional splint[1] are with the Oral Surgery Staff of the S.C.U. 1947 Station Hospital, Camp San Luis Obispo, Calif.

The advantage in using this appliance lies in the fact that the appliance can be adjusted in two distinct steps; whereas, previously, the entire assembled splint and attached pin had to be placed in the mouth in one operation, with the difficulty of adjusting and securing the splint and, at the same time, fighting the muscle pull of the posterior edentulous fragment.

The appliance consists of a removable pin extension that can be readily attached to a splint receiving support from teeth in the arch. The pin extension can be

*Lieutenant colonel (DC), U. S. Army; chief oral surgeon, Station Hospital, Camp San Luis Obispo, Calif.

applied after the splint has been placed and secured to the teeth, at which time manual reduction is brought about and the displaced edentulous posterior fragment is retained in the desired relationship to the main body of the mandible.

Since the advent of chemotherapy, the risk of infection, due to the manipulation of fragments during the process of taking impressions for splint construction, a compound condition usually existing if there is a considerable degree of displacement, is nullified to a great extent; but this in itself should not be sufficient argument to prevent the use of this method, because, in nearly all other methods of obtaining satisfactory reduction in this type of fracture, or where it has been necessary to insert into or against bone tissue some form of screw or pins, open reduction is necessary.

The following case history illustrates the results of a typical case using the modified splint.

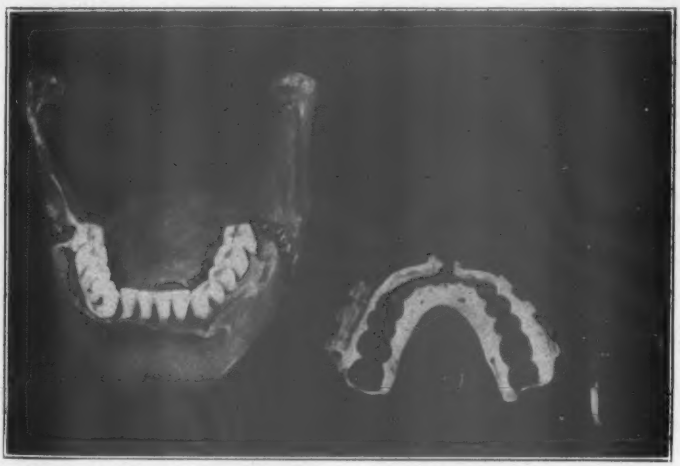

Fig. 1.—Model and disassembled modified clear acrylic splint with pin attachment.

REPORT OF CASE

History.—An air cadet, aged 26, was brought by government ambulance to the Station Hospital, at 5:45 p.m., October 10, 1942, after the private car in which he was riding as a passenger had turned over several times in rounding a curve on route U. S. 101, at 2:30 p.m. on that date. The chief complaints were: injury of jaw and chest, laceration of the tongue, paresthesia of the left lower lip ("feeling of ice water") in the area supplied by the terminal fibers of the left mandibular nerve, brush burns of the face and an inability to occlude the anterior teeth. A short period of loss of consciousness had followed the accident.

Examination.—On arrival at the hospital, the patient was in a state of mild shock. The pulse was of good volume and the blood pressure was: systolic, 142; diastolic, 86. Examination revealed a compound, comminuted, complete fracture, distally from the lower left third molar and extending through to the lower border of the body of the mandible. The left ascending ramus was displaced forward and laterally approximately 1 cm., with considerable separation of the fragment ends. A second fracture, between the right lower second bicuspid and the first molar, extended through to the lower border of the body of the right side of the mandible, with slight comminution, but no significant displacement.

There were abrasions of the right side of

Fig. 2.—Model and assembled splint; clear sectional acrylic splint labial and lingual segments joined by two hinge connectors fixed in position on model with ligature wire passed through interproximal spaces, and through drill holes in buccal and lingual sections of splint; square tube on left side for anchorage of intra-oral extension pin, locked in position by means of second pin passed through hole drilled into square tube and extension pin. Buccal undercut buttons are to be used if desired for additional support by means of intermaxillary rubber bands to the upper arch. The one advantage, an important one, is in the fact that if constructed in this way the extension arm or pin can be removed for adjustments without removing the entire appliance from the oral cavity.

the forehead, the left side of the chest and the left knee, of moderate severity, and the anterior portion of the tongue had a moderately severe cut. The right upper incisors were fractured and were very loose. There was paresthesia of the left lower lip, and a simple, closed and complete anterolateral fracture of the second, third and fourth ribs on the left side.

Treatment.—October 10, roentgenograms were taken.

October 11, sulfadiazine therapy was instituted.

October 12, full upper and lower hydrocolloid impressions were taken, and an acrylic sectional splint and pin attachment were constructed.

Fig. 3.—Left lateral view from case reported, showing amount of overlap of left ascending ramus fragment displaced forward and laterally approximately 1 cm.

Fig. 4.—Nose and forehead; posterior anterior view showing approximately 1 cm. lateral displacement of lower portion of left ascending ramus, also second fracture between second bicuspid and first molar.

October 13, the blood concentration of sulfadiazine attained a level of 7 mg. per hundred cubic centimeters.

October 14, the loose upper right central incisor and fractured upper right lateral incisor were removed under terminal anesthesia (2 per cent procaine, 2.4 cc.). The fractures were reduced under procaine anesthesia (2 per cent, 16.8 cc.). The intra-oral acrylic splint was placed in position on the lower arch, double eyelet stainless steel wire being placed intra-orally on the remaining upper teeth.

Roentgenographic Report.—The fracture through the angle had been reduced and

Fig. 5.—Nose and forehead; postero-anterior view of fractures, reduced by use of appliance described.[1]

there remained only about 2 or 3 mm. lateral displacement and about the same degree of forward overlap of the left ascending ramus fragment. (October 14.)

October 15, intermaxillary elastic traction was applied.

October 17, chemotherapy was terminated.

November 7, there was evidence (roentgenographic) of callus formation. The splint and intramaxillary wiring were removed, and there was evidence (clinical) of union.

Fig. 6.—Nose and forehead; postero-anterior view of fractures, reduced by use of appliance described.

Fig. 7.—Left lateral view, thirty days after injury. The fracture is reduced, the splint removed and callus formation demonstrated. The fragments are in satisfactory position.

November 16, the patient was discharged from hospital (duration of hospitalization, thirty-eight days).

Outcome.—The anatomic and functional

results were good. Occlusion and joint mobility were satisfactory. There was no deformity, shortening, pain, swelling or nerve dysfunction, and no disability.

Follow-up, December 8, 1942 and January 4, 1943, revealed no change.

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X-RAY IRRADIATION IN FACIAL CELLULITIS

By PETER J. KAPO,* M.D., F.A.C.R., Camp Lee, Virginia, and E. HARRY MCCUE,† D.D.S., Chicopee Falls, Mass.

IN the practice of exodontia, there is occasionally presented the problem of extracting a carious or abscessed tooth complicated by facial swelling, either a cellulitis or an adenitis. Extraction in the presence of an active infection may lead to serious consequences. Preliminary x-ray therapy eliminates the inherent risks.

Infections of the face are dangerous in view of the peculiarities of the facial vascular system and soft tissue structures, with the profusion of blood and lymphatic vessels embedded in a preponderantly fibrous tissue stroma. Saliently, the valveless facial vein communicates with the cavernous sinus via the ophthalmic vein. Important byways are the four potential spaces in the upper part of the neck; namely, sublingual, submaxillary, parotid and parapharyngeal. The sublingual space is found below the mucous membrane of the buccal floor and above the mylohyoid muscle. Within it are the submaxillary duct, the lingual and hypoglossal nerves and the lingual artery and veins. Below and posterior to the sublingual space lies the submaxillary space, with direct communication between the two. The enclosed submaxillary gland is in close contact with the sublingual gland. The parapharyngeal space has the shape of an inverted cone with the base attached to the anterior portion of the skull base and the apex ending in the carotid sheath, which invests the common carotid artery, the internal jugular vein and the vagus nerve. Coursing through the space are the great blood vessels and nerves of the neck, and opening into its base are the foramina of the skull. Between the submaxillary and parapharyngeal spaces is set the parotid space, formed by the division of the superficial cervical fascia which enfolds the parotid gland. Passing through this space are the posterior facial vein and, most significantly, the facial nerve. There is a direct communication between the parotid and the parapharyngeal spaces.

The unusual vascularity and pathways of intercommunicating spaces militate against localization in facial infections. The etiologic factor may most commonly be traced to dental involvement, particularly of the lower molars, a fact attributed to the density and poor vascularity of the mandible. The upper molars are less troublesome because the porosity of the maxilla and gravitation facilitate drainage. Inspection will usually reveal advanced caries of the offending tooth,

*Lieutenant colonel, Medical Corps, United States Army; chief of x-ray service, Station Hospital.

†First lieutenant, Dental Corps, Westover Field.

with a putrescent pulp. In the absence of coronal decay, a roentgenogram may disclose a periapical osteolysis typical of an abscess. Almost invariably, smears and cultures will yield a growth of *Staphylococcus aureus* and, rarely, a streptococcus. A spread from the inflamed focus may take place by direct extension through the periosteum or by way of the vascular channels, either venous or lymphatic. In the soft tissues, the travel is along established pathways guided by muscle and fascial planes. Infections of the anterior portion of the mandible, which may penetrate the lingual plate, tend to extend above the attachment of the mylohyoid muscle into the submucosa, above the sublingual and submaxillary spaces. From the lower molars, however, there is likely to be a direct involvement of these important spaces. Involvement of the sublingual space is indicated by elevation of the tongue, tenderness, pain on swallowing and a systemic reaction. External swelling means secondary involvement of the submaxillary space. Spreading from the submaxillary space by contiguity may affect the parotid space, leading to parotid swelling, pain extending over the temporal region and marked trismus. The saliva in parotid space infection is a clear watery fluid as contrasted with the turbid saliva of parotitis. The most serious infections are those of the parapharyngeal space, vulnerable because of its proximity to the parotid space. By way of the foramina, cerebrospinal complications may ensue, or a descent into the carotid sheath may result in a mediastinitis.

A wide variety of treatments have been proposed for the control of these potentially fatal infections. Their seriousness becomes readily apparent from the anatomicophysiologic relationship. Conservative measures include the use of either hot or cold applications, injection of antistreptococcal serum and, more recently, the administration of the sulfa drugs. There are those who regard every case as an emergency and who resort to anything from a simple incision and immediate extraction to a radical exploration, ligation of veins, injection of phenol and local cauterization. Incisions carried deeply from the ear to the mandibular arch have on occasions yielded not one drop of pus. Unquestionably, there arise cases in which radical surgical measures become imperative, or a tracheotomy becomes necessary, or a bone sequestrum must be removed. However, we have had a series of twenty cases in private practice with varied involvement that were immediately given x-ray therapy along with supportive measures, and the only surgical procedure necessary in but a single case was a small linear incision and that in a patient who delayed submitting to x-ray therapy.

In recent years, there has become apparent a widespread appreciation of the inherent value of x-ray therapy for the relief of a variety of infections. We have found inflammation of the face especially amenable to irradiation. In the presence of cellulitis, the dentist may be requested to eliminate dental foci. The procedure is fraught with danger and should be condemned. We have found in the average acute case that two or three fractional x-ray treatments promptly alleviate pain, reduce swelling, promote resorption of exudate and hasten resolution of the inflammatory tissue. Subsequently, within from a week to ten days, extraction can be safely performed. In the early employment of x-rays for diagnostic purposes, it was observed that inflammatory processes in the path of the rays were frequently ameliorated. The amount of exposure necessary to produce a roentgenogram at that period approximated the optimum fractional dose. With the refinement and speeding up of films and the development of intensifying screens, roentgenograms were obtained with

minute exposure and apparently the value of the x-rays in overcoming infections was forgotten. A revival in this treatment took place in foreign circles about thirteen years ago and it has recently attained extraordinary popularity.

Research has unveiled the mode of action and established a rational procedure for irradiation in infections. By physicochemical forces, there is created in the circulating blood an increase in the bacteriolytic and bacteriophagic powers through the disintegration of leukocytes. The released endotoxins and antibodies become available for action in any inflammatory foci. Irradiation locally promotes lymphatic flow by a dispersion of the infiltrating leukocytes. A relative alkalinity ensues, and osmosis is accelerated by increased permeability of the cell walls. Excessive doses appear to temporarily aggravate an infection by overloading the tissues with the products of disintegration.

Although most cases undergo complete resolution and absorption, spontaneous intra-oral eruption and evacuation follow in others, and, in only a few, a small external incision may be needed to evacuate collected pus. The painful swelling consequent to a difficult dental extraction may be relieved within from twenty-four to forty-eight hours, with shortening of convalescence appreciably below that offered by the conventional methods of treatment.

Favorable effects are gained by fractional doses of 60 to 80 r administered daily over a period of three or four days. Voltage ranges from 80 to 130 KPV, with 0 to 5 mm. of aluminum filter, have yielded equally good results. Chronic infections yield to larger doses and the higher filtration values.

CONCLUSIONS

X-ray therapy is effective and safe in the facial infections confronting the dentist because (1) recovery is relatively prompt; (2) ugly operative scars are avoided; (3) the danger of fatality is eliminated, and (4) subsequent dental extraction becomes a normal procedure.

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EFFECTS OF ESTRADIOL, TESTOSTERONE, DIETHYLSTILBESTROL AND SEVERAL OF THEIR DERIVATIVES UPON THE HUMAN ORAL MUCOUS MEMBRANE

M. J. RICHMAN, A.B., D.D.S., New York, N. Y., and
A. R. ABARBANEL,* A.B., M.D., Washington, D. C.

TO the discerning clinician, the oral cavity may offer many clues to the metabolic and nutritional status of the patient. It is a particularly reliable mirror of deficient intake or utilization of various components of the B-vitamin complex. At times, it offers an index of hydration. Too, disturbances in maturation of the teeth may offer evidence of thyroid deficiency, while overgrowth of the maxillae and mandible may be a sign of acromegaly. The oral mucosa has also been suspected of presenting evidence of certain endocrinopathies, in particular those associated with the gonad. In some individuals, premenstrual vascular engorgement of the gingivae, resulting in bleeding from the gums on brushing the teeth, has long been recognized as a clinical entity. The tendency for alveolar bleeding to occur much more freely during the early phases of the menstrual period in the performance of certain dental procedures is common knowledge. During pregnancy, the alveolar mucosa may hypertrophy even to the stage of an epulis. This has been ascribed to the action of the unusually large amount of estrogen present at that time. That this is not the whole story seems apparent, for one of us (A.R.A.) has administered large doses of estradiol and diethylstilbestrol to many women over long periods of time without being able to produce this phenomenon. Perhaps the large amount of progestogen (presumably progesterone) in the pregnant woman is the exciting factor, while the estrogen merely plays a "priming" rôle.

With the growing recognition that the so-called sex hormones—estradiol, progesterone, testosterone—as well as the synthetic diethylstilbestrol, have multiple constitutional activities, a special dental division was created in the gynecologic endocrine clinic. The effects of various substances were studied. These include estradiol dipropionate, estradiol benzoate, diethylstilbestrol, diethylstilbestrol monomethyl ether, testosterone propionate and methyl testosterone. Some of the data obtained with the first four substances form the basis of this report.

Certain recent trends in endocrine physiology should now be pointed out in order to present a clear and unified picture. Proceeding on the basis that all biologic reactions are essentially chemical, the biologist, chemist, physiologist, anatomist and pharmacologist have combined with the clinician in attempting to evaluate the multiple activities of the "sex" hormones. (Fig. 1.)

In the first place, the biologist has conclusively demonstrated that each of these steroidal chemical substances displays bisexual activity. Since neither estradiol nor progesterone, nor testosterone, is specific for either sex, the terms "female sex hor-

*Department of Obstetrics and Gynecology, George Washington University School of Medicine.

From the Dental Division of the Gynecologic Endocrine Clinic, Harlem Hospital, New York, N. Y.

mone" and "male sex hormone" actually are misnomers, for no such entities exist. For example, testosterone, which is so glibly called the male sex hormone, actually is quite a potent "female sex hormone" as well. For example, this steroid will bring about opening of the vaginal canal in a prepuberal ovariectomized rat and cause the growth of the uterus to or toward normal. These activities are presumably the specific properties of estradiol (or its derivatives), the so-called female sex hormone. Moreover, it is known that if the ovaries of a pregnant female rat are removed, the animal will promptly abort unless sufficient progesterone is administered. Yet testosterone may be substituted for the progesterone, the second so-called female sex hormone. On the other hand, administration of progesterone may restore to or toward normal the prostate of a castrated male rat, an action supposed to be the specific property of the so-called male sex hormone, testosterone. Many other such examples could be given. For the interested reader, the literature has been summarized elsewhere.[1]

In view of these findings, then, it seems obvious that the action of any one of these steroids may be in the direction of maleness or femaleness, or both. If it is in the direction of maleness, the action of that particular substance is described as androgenic; if it is in the direction of femaleness, it is described as gynecogenic. The gynecogens may be subdivided into estrogens, which bring about proliferative changes, and progestogens, which cause progestational (pregravid) or maturation changes. Thus, testosterone possesses multiple gynecogenic activities, being estrogenic in its effects upon the vagina and uterus, and progestogenic in its ability to carry an ovariectomized pregnant rat to term. On the other hand, testosterone is androgenic in its influence upon the penis, prostate and seminal vesicles of the castrated male rat. Similarly, progesterone may be androgenic in its effects upon the male; while, in the female, the effects of progesterone may be androgenic as well as progestogenic. In the same manner, estradiol may be androgenic in its influence upon the prostate of the castrated male and gynecogenic in its effects upon the male breasts.

TABLE 1.—SURVEY OF RELATIVE BISEXUAL ACTIVITIES OF TESTOSTERONE, PROGESTERONE, ESTRADIOL AND DIETHYLSTILBESTROL*

Activity	Testosterone	Progesterone	Estradiol	Diethylstilbestrol
Androgenic (toward maleness)	Strong	Moderate	Very weak	Very weak
Gynecogenic (toward femaleness)	Moderate	Moderate	Strong	Strong
(a) Estrogenic (proliferation)	Moderate	Weak	Strong	Strong
(b) Progestogenic (maturation)	Moderate	Strong	None	None

*Structural formulae of the natural hormonal steroids—testosterone, estradiol, and progesterone—containing a common cyclopenteno-phenanthrene nucleus. In contrast, diethylstilbestrol is a synthetic, non-hormonal chemical compound, a derivative of stilbene, and ultimately of ethylene.

As important as the findings of the biologist have been the discoveries of the physiologist and pharmacologist in demonstrating that each of these so-called sex hormones display multiple constitutional activities in both the male and the female that are independent of any effects upon the secondary sexual apparatus. Thus, one or all of these substances may influence the metabolism of fat, protein, carbohydrate, creatine and calcium, as well as affect the condition of the nasal mucosa and the peripheral vascular tree, the pigmentation of the skin, the condition of the kidney tubules, basal metabolism, growth, etc.[2] In short, as one of us noted in a recent report,[3] the genital tract no longer may be considered as a periscope with which to view the extragenital ef-

fects of estradiol, progesterone and testosterone. Rather, these chemicals are to be regarded as constitutional substances irrespective of their effects upon the secondary sexual apparatus.

Even more significant have been the contributions of the chemist in revealing that the steroid nucleus is not essential for gynecogenic activity. In a series of experiments that form one of the most interesting chapters in recent medical progress, Dodds and his co-workers dismembered the steroid skeleton of estradiol in order to discover just what part of it was necessary for gynecogenic activity. With the calculating precision of the scientist

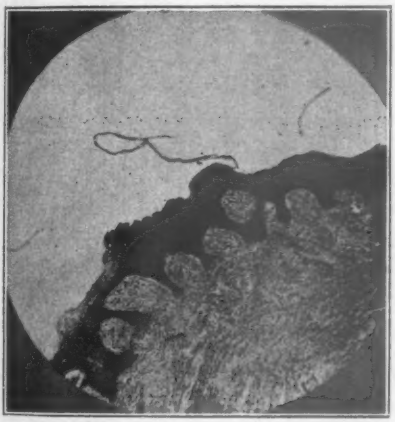

Fig. 1.—Atrophic buccal mucosa. (Low power.) Atrophy of the germinal layer is especially evident, particularly in the prickle-cell portion.

and the unbounded enthusiasm of a small boy taking a watch apart to find out what makes it tick, these chemical detectives evolved scores of non-steroidal substances possessing gynecogenic activity.[4] The most active, milligram for milligram, proved to be 4,4′ dihydroxy-alpha, beta, diethylstilbene or diethylstilbestrol, popularly known as stilbestrol. (Fig. 1.) Pharmacologically, diethylstilbestrol was found to be essentially similar to estradiol in every respect but one. Diethylstilbestrol is not inactivated by the liver, while estradiol is. As a result, diethylstilbestrol loses little of its activity when administered orally.

In review, then, it is noted that the so-called sex hormones, estradiol, progesterone and testosterone, as well as the non-steroidal, synthetic diethylstilbestrol, display multiple constitutional activities that are independent of the effects of any one of them upon the secondary sexual apparatus. In their influence upon the latter, the activity of each of these chemical substances may be bisexual, acting in either sex as an androgen or gynecogen,

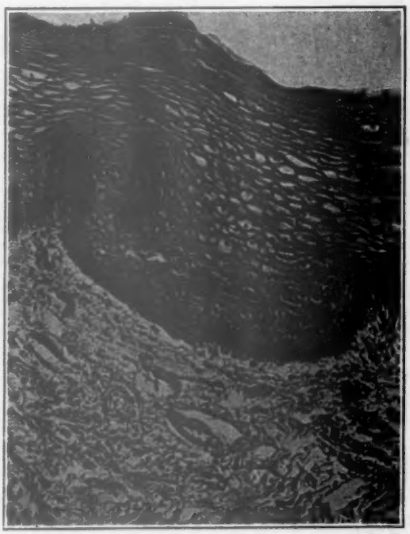

Fig. 2.—Atrophic buccal mucosa. (Medium power.) The decrease in size of the prickle-cell portion is clearly evident. There is diminished vascularity. Slight keratinization of the corneal layer is present.

or both. The relative bisexual activities of these steroids is briefly outlined in Table 1.

Both of us had long been impressed with the association of burning mouth (stomatodynia, "painful mouth") and dryness of the mouth (xerostomia) in climacterics. It was noted by one of us (A.R.A.) that concomitant with relief from the characteristic hot flushes, on

TABLE 2.—CORRELATION OF PRETREATMENT GROSS ORAL MANIFESTATIONS, SUBJECTIVE SYMPTOMS, AND HISTOLOGIC STUDIES OF BIOPSIES OF THE BUCCAL MUCOUS MEMBRANE WITH CHANGES INDUCED AFTER TREATMENT WITH ESTRADIOL AND DIETHYLSTILBESTROL.

Case	Age	Menopause		Pretreatment Observations							Changes After Estrogen Therapy						
				Objective Signs	Subjective Symptoms			Microscopic Findings			Objective Signs	Subjective Symptoms			Microscopic Findings		
		Duration in Months	Surgical Spontaneous	Mucosa	Gingival Bleeding	Dryness	Burning	Atrophy of Germinal Layer	Keratosis	Leukoplakia	Mucosa	Gingival Bleeding	Dryness Burning	Increase in Salivation	Hyperplasia of Germinal Layer	Keratosis	Leukoplakia
1	42	1	Surgical	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
2	32	1	Surgical	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
3	34	2	Surgical	Gray-pink	Occasional	+	0	0	0	0	0	0	0	+	++	0	0
4	49	3	Surgical	Normal	0	0	0	0	0	0	0	0	0	0	0	0	0
5	34	6	+	Dull pink	+	0	0	+-	+++	0	Rosy pink	0	0	0	+++	++	0
6	32	10	+	Grayish	0	+	0	+	+	0	Bright pink	0	0 1	+	++	+	0
7	48	12	No	Grayish	0	0	0	+++	+++	+	Pink	0	0	0	+++	++	*
8	38	12	+	Dull pink, white streaks	0	++	+	+++	++	0	Pink	0	0	+	++	++	0
9	40	12	+	Gray, white streaks	0	++	+++	+++	+	+	Same	0	0	+	+	+	+
10	42	12	No	White streaks	0	++	++	++	+++	0	Pink	0	0 1	+	+++	+	0
11	45	15	+	Dull pink, streaking	0	0	0	+++	+	0	Pink	0	0 0	0	++	+	0
12	46	15	+	Gray streaks	0	0	0	0	0	0	Same	0	0 0	0	+	0	0
13	36	18	+	Dull pink, streaking	0	0	0	+++	+++	0	Rosy pink	0	0 0	0	++	+++	0
14	34	18	+	Grayish	++	+++	++	+	0	0	Pink	Pink	0	0 0	+	++	0
15	33	24	+	Grayish white streaks	0	++	++	+++	+	0	Rosy pink	0	0 0	+	+++	+	0

15	33	24	+	Grayish white streaks	0	++	++	+++	+	0	Rosy pink	0	0 0	+	+++	+	0
16	49	24	+	Dull pink, streaking	0	0	0	0	0	0	Same	0	0 0	0	0	0	0
17	51	27	+	Streaking	0	0	0	+++	++	0	Pinker	0	0 0	0	++	+	0
18	40	27	+	Grayish, whitish patches	0	+++	++	+++	0	0	Rosy pink	0	0 0	++	+++	0	0
19	41	30	+	Gray	0	+	+++	++	+++	0	Rosy pink	0	0 0	++	+++	+1	0
20	51	40	+	Diffuse grayish streaks	0	++	+	++	0	0	Bright pink	0	0 0	+	+++	0	0
21	45	30	+	Grayish white patches	0	0	0	+++	++	0	Rosy pink	0	0 0	0	+++	+	0
22	58	33	+	Dull pink, white patches	0	0	0	+++	+++	++	Pinker	0	0	0	++	++	++
23	37	36	+	Grayish milky film	0	+++	+++	+++	+++	+	Pinker	0	0	++	+++	++	+
24	40	48	+	Gray	0	0	+++	+	+	0	Rosy pink	0	0	++	++	+	0
25	44	48	+	White patches	++	0	0	+++	+++	0	Pinker	0	0 0	+	+++	+	0

suitable therapy (estradiol or diethylstilbestrol) the oral symptoms tended to disappear. Review of the literature revealed a paucity of reports on this subject. Nathanson and Weisberger, in a study of the effects of administration of estrone and estradiol on leukoplakia buccalis and related lesions, clearly described the associated gross lesions before and after therapy, but reported no microscopic study.[5] In the ovariectomized monkey, Ziskin[6] noted stimulation and growth of the gingival mucosa with estrone and estradiol. On the basis of a simple biopsy in three patients, Ziskin concluded that in the human being, estradiol may stimulate growth and keratinization of the gingival mucosa.[7]

In view of the incomplete reports in the human being, these studies were carried out. Any difference in the action of estradiol and diethylstilbestrol was observed. Estradiol dipropionate and diethylstilbestrol-monomethyl-ether, dissolved in sesame oil, were injected either deeply subcutaneously in the arm or locally beneath the buccal mucosa. Estradiol benzoate was used in a few cases, but its use was discontinued soon after the much more prolonged action of estradiol dipropionate was appreciated. Diethylstilbestrol, as well as its monoethyl-ether, was administered orally. Twenty-five climacteric cases were carefully studied over a period of eighteen months. In seventeen, the menopause was surgically induced. Gross oral manifestations, subjective symptoms and biopsies of the buccal mucosa before, during and after therapy were correlated. Biopsies of the buccal mucosa were made, the tissue being removed under local anesthesia from the region approximating the first and second molars. Vaginal biopsies were made when a senile vaginal mucosa was evident. The pertinent data are summarized in Table 2.

PRETREATMENT OBSERVATIONS

When the objective visual gross signs

were correlated with the subjective symptoms and the results of the biopsies of the buccal mucosa, a close relationship was generally apparent. As a rule, the longer the period that had elapsed since the cessation of menstruation, regardless of whether it had occurred normally or had been surgically induced, the more frequently were signs and symptoms present. Accordingly, several stages were observed, each blending into the next one, so that a strict classification was not possible for any one particular group of oral signs and symptoms. As a rule, symptoms did not appear until about six months after cessation of menstruation.

Fig. 3.—Basal portion of buccal mucosa after therapy with estradiol dipropionate (diovocylin). (Same magnification as Figure 2.) The increased vascularity is clearly evident from the enormous increase in the capillary bed. The growth of the prickle-cell portion is to be noted.

In those patients studied within six months after the menopause, the buccal mucosa almost always was a normal rosy pink and appeared moist and smooth. Histologically, the mucosa was normal. With time, however, there appeared varying stages of atrophy associated with definite clinical symptoms and gross signs.

Stage I. Beginning from about six months to a year after the menopause, the buccal mucosa may become pale pink. Later, it appears grayish with a light pink background. Concomitant with these objective signs, symptoms of burning or dryness, or both, become manifest with increasing frequency. Biopsy reveals a beginning atrophy of the mucosa, most clearly evident in the prickle cells of the germinal layer. There the cells become round, smaller and darker staining. The number of layers is apparently reduced. The basal-cell layer gradually comes to be represented by a thin line of cells. At this time, the corneous layer may begin to show areas

Fig. 4.—Upper portion of buccal mucosa of field shown in Figure 3 after treatment with estradiol dipropionate. (Same magnification as Figs. 2 and 3.) The physiologic hyperplasia of the prickle-cell is manifest. Very slight keratinization of the corneal layer is present.

of early keratosis, as indicated by a slightly increased number of cornified, flat cells with small or occasionally absent nuclei. Mitoses are not seen. Essentially similar histologic pictures are to be noted in the postmenopausal vulvovaginal tract.[8]

Stage II. With the passage of time in the untreated case, the buccal mucosa tends to develop milky whitish gray areas. These may be localized to one or two

areas, patchily distributed or diffusely streaked. In other areas, the mucous membrane seems a pale gray with just a faint touch of pink, as though the blood supply to the mucosa had in some manner been reduced to the merest dribble. The gingival mucosa is now noted to bleed quite easily even on gentle manipulation. This condition is usually corroborated by the patient's voluntarily offering the information that the gums usually bleed when she brushes her teeth. At this time, burning and dryness are common complaints. Histologic examination reveals that the atrophy of the prickle layer is now more advanced,

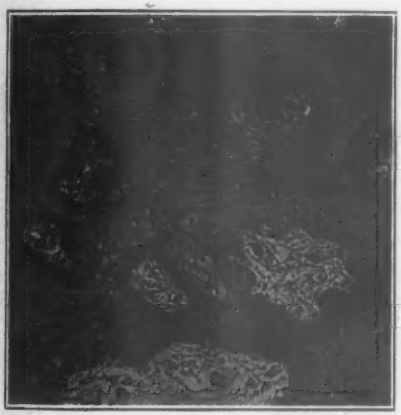

Fig. 5.—Portion of field in Figure 3 (high power) showing increased vascularity and physiologic hyperplasia of germinal layer, especially prickle-cell portion.

while the corneous layer begins to show signs of increased keratinization with isolated areas of hyperkeratosis occurring with increasing frequency. "Pegs" of epithelial downgrowth may appear at this time. A similar picture has been noted in the atrophic processes affecting the postmenopausal vulvovaginal tract.[8]

Stage III. As time passes, a few patients may develop areas on which a milky whitish to dirty gray adherent film has formed. Attempts at removal result in a raw freely oozing surface, or the film may be so firmly adherent that it cannot be lifted off the mucosa. In other areas, the mucous membrane appears to have the thinness of cigaret paper. It may be finely wrinkled. As a rule, it is a dull gray with a faint tinge of pink. The patient usually has a continuously flat taste in her mouth. Often, she has a poor appetite. In some instances, the taste of the food has greatly diminished or even disappeared. The mouth seems to be dry all the time, and relief is not secured by frequent rinsing or the imbibition of water. In some patients, a particularly intense burning may be present.

Fig. 6.—Atrophic vaginal mucosa. (Low power.) (Compare Fig. 1.)

Histologic examination at this time shows further atrophy of the germinal layer, particularly in the prickle-cell portion. In the areas where the whitish, almost opalescent film was located, varying stages of actual leukoplakia are clearly evident. Striking indeed is the microscopic appearance of the buccal mucosa during the varying stages of atrophy and the development of keratosis to the stage of actual leukoplakia, when it is compared with similar processes in the vulvovaginal tract.[8] The pictures presented are extraordinarily similar.

OBSERVATIONS AFTER TREATMENT

In those patients classified as in Stage I or II, the mucous membrane soon returned to the normal bright rosy pink, while it was definitely more moist. The sensations of burning and dryness disappeared early. Many patients noted an increase in salivation. After a time, gingival bleeding on brushing the teeth was no longer evident.

Biopsies were made at frequent intervals in the same patient, ranging from one week to a year or more after therapy was instituted. Although a large number of patients were observed for changes in gross objective signs and subjective symptoms, sufficient and satisfactory biopsies after the start of treatment were made in only twenty-five women. These biopsies revealed the following changes: Soon after estradiol or diethylstilbestrol was given, the prickle-cell layer began to grow. The cells became larger and increased in number. Mitoses were frequently observed. The basal cell layer also showed signs of increased activity. The corneous layer increased slightly in size, while the outermost cells were more evenly keratinized. The epithelial downgrowth tended to "flatten out." Striking indeed was the markedly increased blood supply evident in the rete papillae. The capillary networks were engorged and easily visualized in contrast to the seemingly avascular submucosa before treatment was started.

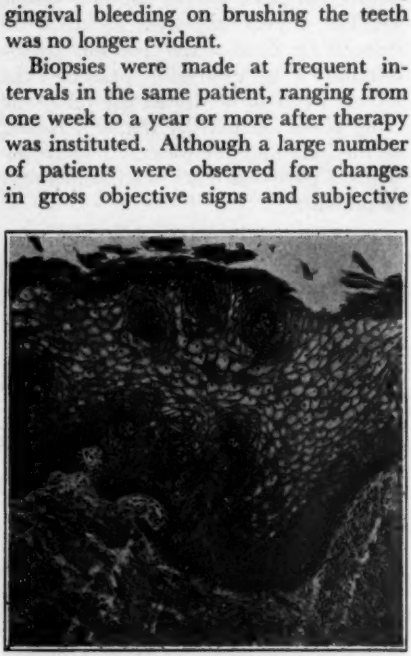

Fig. 7.—Vaginal mucosa (low power) after treatment with estradiol dipropionate (di-ovocylin). The physiologic hyperplasia of the stratum germinativum epidermidis (malpighii), particularly of the prickle-cell layer, is clearly evident. (Compare Figs. 5 and 6.)

Where leukoplakia (Stage III) had been observed previously, there usually was no change, although in a few cases there was evident a slight decrease. Not once was an actual increase in keratosis observed. In other respects, these patients responded to these substances in the manner described in Stages I and II.

Control material was drawn from those climacteric cases that were found to respond to triple bromides or in which injections of sterile sesame oil or lactose tablets by mouth were first given. In not one instance of an atrophic buccal mucosa were stimulative effects observed to follow the administration of these substances. It should be emphasized that the diet of these patients was checked and where any doubt existed as to the food intake, large doses of the vitamin B group, plus fish liver oil (for vitamins A and D), were prescribed. Except for a possible increased sense of well being in these patients, the oral signs and symptoms were unchanged.

METHOD OF ADMINISTRATION AND CHOICE OF ESTROGEN

By far the most efficient and most rapidly effective method of administration was the injection of 1 mm. of estradiol dipropionate (di-ovocylin), dissolved in sesame oil, under the buccal mucosa. Usually, after a few such treatments, the subjective response was most gratifying. The treatments were generally given once or twice a week at first, then tapered off to once in two or three weeks. Interestingly, the hot flushes were also relieved, while the vaginal mucosa evidenced physiologic stimulation. Di-

ethylstilbestrol-monomethyl-ether was found to be much less effective, milligram for milligram, while in an occasional case some nausea occurred. This substance yielded by far the poorest results in this study. Clinically, this compound possessed about one-fifth to one-twentieth the potency of estradiol dipropionate.

When diethylstilbestrol was administered by mouth, equally effective results were eventually secured, but more time was required to secure them. The usual dose ranged from 0.1 to 1 mg. daily.

As far as the oral response was concerned, the intramuscular or subcutaneous route proved to be much slower and far less effective in achieving the desired result as compared with the local injection of estradiol dipropionate under the mucobuccal fold. Nightly massage with an ointment base containing either estradiol or diethylstilbestrol was also not so efficacious as the local injection method, but did prove to be an excellent adjuvant for maintaining progressive improvement.

DISCUSSION

Analysis of the data discloses that, as a general rule, there appears to be a close correlation between the visual objective signs and the subjective symptoms on the one hand and the histologic picture on the other. It should be emphasized that not all women develop postmenopausal atrophy of the buccal mucosa, nor do they necessarily develop xerostomia or stomatodynia. Further, not all patients with an atrophic buccal mucosa need develop oral symptoms.

The evidence, however, is strongly suggestive and the experimental data secured after treatment with estradiol or diethylstilbestrol corroborate the premise that the buccal mucosa in the human female is normally under the trophic influence of the gonadal steroid, estradiol. Both the natural steroid estradiol and the synthetic non-steroidal diethylstilbestrol were found to exert an estrogenic (proliferative) influence upon the atrophic human buccal mucosa resulting in complete restoration of the latter to normal in Stages I and II, and toward normal in Stage III. Our gross observations coincide with those reported by Nathanson and Weisberger,[5] with the single exception that they reported disappearance of the leukoplakic areas, an observation that we could not confirm, although, in some cases, there did occur some apparent diminution in size. Our microscopic studies confirm those of Ziskin in the monkey and show that they are similar in the human being. Similar observations on the effect of these estrogens upon the human senile vulvovaginal tract have been made by one of us (A.R.A.).

Furthermore, our histologic studies on the changes produced by administration of the estrogens in question lead us to agree with Nathanson and Weisberger concerning the probable source of some forms of leukoplakia buccalis in the postmenopausal period. The first stage appears to be an atrophy of the buccal mucosa, particularly the germinal layer, primarily involving the prickle-cell layer. This atrophic process apparently stems from a deficiency of the ovarian steroids, estradiol and its derivatives. That not all persons whose ovaries have been surgically removed do develop atrophy of the buccal mucosa seems to point to the fact that these steroids may have an extragenital source, the evidence at hand seeming to point to the suprarenal cortex.

This atrophic buccal mucous membrane reacts in an abnormal manner to stimuli which under ordinary circumstances would not affect the normal oral mucosa. This abnormal response may become manifest by the development of a thickened keratinized corneous layer of the otherwise thinned-out mucosa. This hyperkeratinization is probably a defense mechanism arising because of the various irritants to which the oral mucosa

may frequently be subjected. In some persons, the defensive piling up of keratinized corneal cells may reach the pathologic state known as leukoplakia buccalis. Further, in some of these cases, the pathologic growth pattern may proceed to a malignant stage.

The experimental data disclose that administration of estrogens (estradiol or diethylstilbestrol) promotes a normal growth pattern in the human oral mucosa. The prickle cell layer undergoes a physiologic hyperplasia, while the basal cell layer shows signs of increased activity. The corneal layer may become keratinized, but, it must be emphasized, this is normal in extent, being similar to that seen in the vaginal mucosa. No evidence of a hyperkeratosis or leukoplakia of the oral mucosa was observed to develop on estrogenic therapy. Similar observations have been noted in the response of the senile vulvovaginal tract to administration of estrogens.

In short, it is obvious that administration of estrogen elicits a normal growth response in the oral and vulvovaginal mucosae of the human being. In this manner, estrogen administration would tend to prevent the development of leukoplakic areas by restoring a normal growth and metabolic pattern of an atrophic mucosa. Since leukoplakia of the mouth or of the vulva is held by many to be a precancerous lesion, it seems that estrogen actually exerts a prophylactic action in preventing the development of hyperkeratosis or even leukoplakia. Where leukoplakia does exist, estrogen tends to prevent the further extension of the process; while, in some cases, an actual reduction in extent of the lesion was apparently observed. Whether an increased dosage of estrogen or further continuation of estrogen therapy would result in eventual disappearance of the leukoplakic areas cannot be stated at this time from our own data, but Nathanson and Weisberger apparently did observe, grossly, just such a phenomenon in their series.

It was difficult to determine the significance of the increase in salivation noted in some patients. That it may have been a factor in relieving the sensation of dryness or burning, or both, cannot be affirmed or denied with the data at hand.

CLINICAL CORRELATIONS

From a clinical viewpoint, the observation that the gingival bleeding disappeared on estrogenic therapy has proved very significant. It has been utilized by one of us (M.J.R.) in the management of senile or atrophic gingivitis. In this condition, the gingivae develop atrophic changes similar to those described above. In addition, the mucosa becomes so fragile that it bleeds easily on brushing the teeth or on pressure, such as that of a denture. After an investigation of several methods and combinations of treatment, the following schedule has proved to yield the most consistent results. One milligram of estradiol dipropionate dissolved in sesame oil is drawn up into a 2 cc. syringe with a 2-3 inch (No. 20) needle. The estrogen is injected slowly beneath the mucobuccal fold adjacent to the area to be treated. The needle is slowly withdrawn at the same time that the solution is being expressed in order that too great an accumulation in one place may not result. Multiple injections may be used, if preferred. The usual dosage has been 1 mg. of estradiol dipropionate (diovocylin) once or twice a week for two or three weeks, then once in every two or three weeks, the time depending on the patient's response. In the case of patients who are wearing dentures, adjunctive therapy with estradiol or diethylstilbestrol ointment may be employed. The ointment is rubbed on the plate just before it is inserted. In some cases, either estradiol or diethylstilbestrol ointment was used, being massaged into the gum tissues by means of rubber applicators. All in all, however, by far the most satisfactory results were obtained with local

injection of estradiol dipropionate under the mucobuccal fold. Bleeding from the gums ceased in all those cases that were treated. In a few patients who were wearing dentures, an early regression of the gingival margins was apparently arrested.

SUMMARY AND CONCLUSIONS

1. In a series of twenty-five climacteric cases, gross oral manifestations, subjective symptoms and biopsies of the buccal mucosa were correlated before, during and after therapy with estradiol dipropionate, estradiol benzoate, diethylstilbestrol and diethylstilbestrol-monomethyl-ether.

2. As a result of declining ovarian activity, manifested clinically by the cessation of menstruation (menopause), atrophic changes may occur in the oral mucosa, similar to those developing in the vulvovaginal tract.

a. Objectively, the normal pink fades, the mucosa becoming pale and anemic looking. Grayish white areas appear in patches or streaks or else diffusely scattered. Finally, a whitish adherent film may be noted in some areas.

b. Subjectively, and concomitantly with these gross changes, a sensation of dryness or flatness of taste or burning may be observed by the patient. Gingival bleeding may be noted in some cases.

c. Histologically, the first stage consists of atrophy of the germinal layer in general and the prickle cells in particular. With time and irritation, the corneous layer, under an abnormal growth stimulus, may become the site of hyperkeratosis or, eventually, leukoplakia.

3. After therapy with estradiol or diethylstilbestrol, the following changes occur:

a. Grossly, the normal bright moist pink of the oral mucosa returns.

b. Subjectively, the symptoms of burning and dryness disappear, while an increase in salivation is noted in some cases. Gingival bleeding no longer is noted.

c. Histologically, there occurs a physiologic hyperplasia of the prickle-cell layer, increased activity of the basal cells and, in some cases, a smooth, even keratinization of the corneous layer. At no time was hyperkeratosis induced by administration of these estrogens. In fact, in a few instances, leukoplakic areas seemed to diminish in size.

4. The vulvovaginal mucosa responds to estradiol and diethylstilbestrol therapy with changes histologically similar to the changes occurring in the oral mucous membranes.

5. The management of senile atrophic gingivitis with estradiol dipropionate administered by injection under the mucobuccal fold was found to yield the most satisfactory results. Bleeding from the gums was arrested and the mucosa was restored to its normal condition. In a few patients, regression of the gingival margins was apparently arrested.

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100 Central Park South, New York.

CONSERVATIVE TREATMENT OF VINCENT'S STOMATITIS

A. Bernard Eskow, D.D.S., and Daniel Elihu Berman, D.D.S., New York, N. Y.

FOLLOWING is a report on the conservative treatment of eighty-five controlled cases of Vincent's stomatitis rising to epidemic proportions (25 per cent) in a localized area in the City of Baltimore.

Accompanying the influx of defense workers and poor, unskilled laborers are many health problems. From the dental viewpoint, the outstanding problem is the improvement of oral conditions in people who have heretofore had no money for proper dental treatment. Ninety-five per cent of the patients manifested exceptionally poor oral hygiene. The neglect of their teeth and gums has been appalling, making them likely candidates for Vincent's stomatitis. It has been noted that the severity of the infection is more marked than normally, a fact that has been confirmed by some of the practitioners in the city.

The infection is characterized by blunting of the crests of interdental papillae, with a grayish white necrotic slough at the tips. A narrow margin of inflammation ran around the gingival crest labially from the lower anterior teeth, lingually from the lower posterior teeth and buccally from the upper posterior teeth. Many of the patients manifested grayish white ulcerations of the labial and buccal mucosa and the anterior wall of the fauces.

Smears, made for purely academic reasons, were taken from about 10 per cent of the group and were returned with a report of large fields of *Spirillum vincenti* and fusiform bacilli present. The smears were stained by either the carbolfuchsin or the methylene blue technic. The mouths were so apparently infected that it was considered unnecessary to take smears for diagnostic purposes.

The course of treatment was carried out with three different technics, lasting over a period of three weeks. The patients were seen daily the first week and three times the second week, and were discharged after the second visit in the third week. The entire treatment lasted about eighteen days, the time depending on the regularity with which the patient attended the clinic.

The first visit was devoted to a complete oral examination, noting condition of the (1) gums, (2) teeth and (3) oral lesions and (4) the type of oral hygiene employed.

The following day, treatment was instituted. Three separate procedures were followed:

1. Thirty-five patients were treated with a pressure spray consisting of a solution of one-half 3 per cent hydrogen peroxide and one-half warm water, washing the loose débris and necrotic tissue away from the gingival areas of the teeth. The teeth were then swabbed with cotton applicators immersed in 3 per cent hydrogen peroxide. The mouth was sprayed again with the solution, and tincture of merthiolate was applied to the gums. This was continued daily for five visits. After the fifth visit, the teeth were carefully polished with pumice and water, to remove excess débris. Each visit thereafter, a few teeth were scaled until all tartar had been removed from the dental arches. At the end of the second week, the teeth were polished again and the patients were informed that they might start brushing their teeth. Complete instructions and a pamphlet were given to each of the patients on proper tooth-

brushing technic. At the first visit of the third week, the mouths were sprayed with the diluted solution of hydrogen peroxide, and tincture of merthiolate was applied to the gums. Upon the second visit of the third week, the mouths were inspected, and no clinical signs of Vincent's infection could be found. The patient was then discharged and asked to return in two weeks. No signs of Vincent's stomatitis could be found at this visit.

2. The second thirty-five patients were treated in the manner described previously. In this group, tincture of metaphen was substituted for tincture of merthiolate.

3. The remaining fifteen patients were treated with a pressure hydrogen peroxide spray and the application of a 5 per cent solution of chromic acid to the necrotic tips of the interdental papillae. This was followed by a sodium bicarbonate mouthwash. After all signs of infection had cleared up, the teeth were thoroughly scaled and polished.

It was found that the gingivae of those patients treated with the 5 per cent solution of chromic acid cleared up as rapidly as those in which the mercurial antiseptics were used.

The one difficulty encountered with the use of chromic acid was that it blunted the crests of the interdental papillae. This left spaces in which food and débris could collect and in which tartar could easily form. The gingivae, which Nature had originally intended to be pointed and firm, were found to have been blunted.

The mouths treated with tincture of merthiolate or tincture of metaphen, with the teeth conservatively scaled and polished over a comparative length of time, were found to have retained their acuteness and tonicity, no signs that the patient ever had had an infectious stomatitis remaining.

Each patient was given the list of instructions below, which they were required to follow.

1. Observe complete dish, glass and silverware isolation. Boil dishes for three to five minutes in soap and water.
2. Eat and drink only from paper dishes and cups in public restaurants.
3. Throw away toothbrush and do not brush teeth until told to do so.
4. Eat plenty of green leafy vegetables.
5. Force fluids, juices and milk.
6. Use a mouthwash of one-third peroxide and two-thirds warm water every hour.
7. Use a cathartic or an enema to keep the bowels regular.
8. Do no smoking.
9. Make regular visits to dental clinic.
10. Permit no girl with Vincent's infection to handle food or dishes in the kitchen.

Rule 6 was changed to once every four hours after the fifth visit. It is known that these rules and regulations were strictly adhered to, with perhaps the exception of Rule 8, because the patients were under strict supervision for approximately twelve hours a day.

CONCLUSIONS

1. The promiscuous use of escharotics in the oral cavity in the treatment of Vincent's stomatitis is absolutely unnecessary. Their use leaves an abnormal gingival recession and unesthetic gingival contour, which in all probability would never have developed had the case been treated conservatively.

2. The use of a dilute solution of peroxide and water plus a mild mercurial and a complete and thorough prophylaxis have had far better results in as short a period of time as the escharotics were used as a control.

3. In patients suffering a loss of interdental tissue, even with the conservative treatment the papillae were found to have retained their roundness, with no evidence of plateau formation of the gingivae as in the use of chromic acid.

4. Thiamine chloride, 15 mg., and vitamin C, 50 mg., constitute a useful adjunct in the treatment of Vincent's stomatitis.

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THE COUNCIL ON DENTAL THERAPEUTICS

PREVIOUSLY to the passage of the Pure Food and Drugs Act, in 1927, no special effort had been made in the dental therapeutic field to restrain or check the unbridled audacity of the vendors of dental nostrums in their concerted efforts to exploit the dental profession and the public.

The advertising of mouth preparations, dentifrices, toothpastes and dental cosmetics became conspicuously obnoxious because of the false and misleading statements made about these preparations with the sole aim of increasing sales of the various mouth remedies and with no regard to the actual harm which in many instances might be done to the teeth—not to say to the dental morale of the public.

Intensive commercialization of the mouth preparations appeared to be the keynote of dental advertising to the public and the competition became so acute that unwarranted and deceptive statements characterized the promotional efforts of the dental nostrum vendors.

In 1927, the American Dental Association, recognizing the need for more and better information concerning the composition and properties of dental drugs and dental cosmetic preparations, and in an effort to direct the current advertising motive at least in the direction of the

truth, established a bureau of chemistry to act as the corrective agency. The corrective influence was to be exerted through investigation and examination of the formulae of the many products of doubtful value or semisecret composition that were being sold to dentists and to the public and by making the information thus obtained available to both the dental profession and the public.

It soon became apparent, however, that chemical examination alone did not furnish sufficient grounds for the satisfactory evaluation of dental therapeutic products. Accordingly, at the Washington meeting of the American Dental Association, in 1929, the Council on Dental Therapeutics was created, being charged, in directive cooperation with the Bureau of Chemistry, with the duty of investigating and analyzing the advertising claims of the promoters of proprietary remedies being offered to the dentist and to the public, and determining whether they were fraudulent. It was the further duty of the Council to publicize all such fraud.

The enabling bylaw of the Association creating the Council on Dental Therapeutics and the Bureau of Chemistry stipulated that the Council should be made up of ten members, with the Secretary of the American Dental Association and the Editor of THE JOURNAL as ex-officio members. Five of the active Council members were to be dentists and five to be representatives of the basic sciences: physiology, pharmacology, biology, bacteriology and chemistry.

The staff of the Bureau of Chemistry was also enlarged, and the Council on Dental Therapeutics and the Bureau of Chemistry were thus in an excellent position to evaluate dental therapeutic products.

The Association was fortunate indeed in being able to secure five eminently qualified scientists associated with the basic sciences to serve on the Council. These representatives of the basic sciences serve the American Dental Association without remuneration and are men of reputation and authority in their individual fields, bringing to the deliberations of the Council the expert knowledge necessary to pass upon the merits of any proprietary preparation.

The project thus begun by the Bureau of Chemistry was continued by the Council and the Bureau on a broadened basis. Numerous dental nostrums have now been described in the pages of THE JOURNAL in such a manner as to expose the false claims made for them, at the same time furnishing to the dentist sufficient knowledge of the various preparations to enable him to intelligently discriminate in the use and recommendation of them.

The Council has constantly added to the number of unacceptable nostrums and at the present time it is able to devote more attention to the critical evaluation of dental drugs concerning which current scientific knowledge is inadequate. In order to evaluate the usefulness of such drugs, the Council sponsors therapeutic investigations outside its departmental effort, which it supports in part by grants of funds from its yearly budget. The funds alloted to the Council are not sufficient to permit such extensive investigation on the outside as is desirable, but each year the available funds are awarded to qualified investigators for this purpose.

Occasionally, there comes to the attention of the Council a product which in itself has merit, but which is semisecret in composition, is overpriced or is advertised in a misleading manner. In such instances, the product is analyzed in the Bureau of Chemistry and its composition and a statement as to its usefulness are published in THE JOURNAL. In this manner, the Council encourages the marketing of many worth while products on a sound commercial basis and at reasonable prices to the profession.

The efforts of the Council in this direction elicited such commendation from the profession that, at the insistence of many members of the Association, it was induced to undertake consideration and evaluation of dentifrices.

There was some doubt in the minds of the Council as to whether dentifrices intended primarily for toilet use and known to have no therapeutic value came within the purview of the Council's activities. However, the dentifrice situation was so chaotic and so premeated with blatant advertising and falsifications intended to deceive that the Council consented to direct its physical and moral resources toward bringing truth into dentifrice advertising and to encourage the elimination of potentially harmful ingredients from dentifrices.

When one realizes that we no longer hear over the radio such ridiculous and misleading statements as "Three shades whiter in three days"; "Don't let the seven stains spoil the beauty of your teeth"; "Do as your dentist does—use powder," and many other such statements, including claims for mysterious therapeutic ingredients, it is quite apparent that reform in a significant degree has come to dentifrice advertising in the past few years. And we are confident that the Council has had a very important part in this reform.

However, much remains to be done, and we are assured that the

Council's efforts to bring light into the highly controversial dentifrice field will continue undiminished.

Publication and standardization of the composition of local anesthetic solutions have been major contributions of the Council to dentistry. Local anesthetic solutions of secret composition are almost unheard of today. Such impractical preparations as "buffered" commercial solutions of procaine hydrochloride have been quietly eliminated from the market, largely through the efforts of the Council and the Bureau of Chemistry.

The Council also publishes a record of its work in book form under the title "Accepted Dental Remedies," in which the *raison d'etre* for all of its conclusions and statements is given. Also the formulae for all accepted remedies are given together with a list of unacceptable remedies for the guidance of those who follow the lead of the Council. This little book, which can readily qualify as the dentist's therapeutic Bible, deserves a place in every dentist's textbook references.

The efforts of the Council on Dental Therapeutics in the field of dental remedies have not only added much to the confidence and satisfaction in their use by the dentist, but have also added much in prestige and in the promotion of the professional spirit in the therapeutic phase of dental practice.

HIGH SCHOOL VICTORY CORPS

> When our enemies challenged our country to stand up and fight, they challenged each and every one of us, and each and every one of us has accepted the challenge for himself and for the Nation.
> —FRANKLIN D. ROOSEVELT.

The spirit expressed in the words of the President in accepting the challenge to fight for life and liberty has extended far beyond those who are eligible for the actual fighting forces, even to the school room of the secondary schools.

The first material expression of this spirit in the younger and extra-belligerent population is the organization of the High School Victory Corps, a national voluntary organization for secondary schools designed to mobilize secondary school students for more effective preparation for and participation in wartime service.

The American people have become so war minded after twelve

months of active fighting that virtually every American citizen is eager to take an active part in the war movement and "wants most of all to know where and how and when he can best put his shoulder to the wheel." The Office of Education, through the War Manpower Commission, is endeavoring to help answer that question for the school youth of the nation in the organization of a Victory Corps in every secondary school.

The American Dental Association, through its Council on Dental Health, in cooperation with the Government Office of Education, has developed a program designed to assist school officials to complete the dental corrective phases of their physical fitness program. The program provides that the dental profession shall give special consideration to high school students, particularly those who are about to enter the military or the civilian war services. This means that every dentist should, as far as he is able, meet the dental needs of the high school student who seeks his services.

The objectives of the program will be:

1. To graduate from high school, boys and girls dentally fit, so that they will not, because of dental deficiencies, be kept from military and civilian activities in which their services are needed.
2. To correct existing dental defects and to prevent future defects by enlisting the services of the family dentist, and thus help to reduce the heavy burden now being carried by the overloaded military dental corps.
3. To enable high school students entering military or civilian war services to begin training without loss of valuable time necessary for dental rehabilitation.
4. Not only to meet the immediate dental needs of prospective inductees and high school students entering civilian war work, but also to further extend dentistry's long range educational program for control of dental disease.

The Council on Dental Health of the American Dental Association, under the chairmanship of Dr. Emory W. Morris, has formulated a definite plan of procedure for the guidance and direction of the state society in organizing a high school victory corps, and it is urged that each state society communicate with the chairman of the Council to the end that dental defects among the high school students may be immediately and fully corrected and every student be made available for service at least so far as the health of the mouth is concerned.

Dentistry has already made valuable contributions to the war effort, and in this present project we can render invaluable health service to the youth of the nation by equipping them with a masticatory apparatus that will enable them to meet the digestive needs of the body under rigorous war conditions.

BIBLIOGRAPHICAL

Laboratory Directions in Biochemistry.

By VICTOR C. MYERS, M.S., Ph.D., D.Sc. Professor of Biochemistry, Western Reserve University, Cleveland, Ohio. Loose-Leaf Plastic Binding. 288 pages, 17 illustrations. Price $3.50. St. Louis, Mo.: C. V. Mosby Co., 1942.

THIS book is a product of more than thirty years of experience in the teaching of biochemistry. Special emphasis is placed on clinical aspects of the subject. In addition to an ample selection of laboratory tests and experiments in general and clinical biochemistry, the manual includes a section on dental biochemistry. The experiments and test procedures are clearly explained and references to the original publications on which they are based are given in many instances.

Supplementary material includes a course outline for coordinated lectures and laboratory work, a discussion of the use of visual and photo-electric colorimeters, reference texts, experiments for students who have not completed acceptable work in quantitative analysis and tables of metric equivalents, logarithms and atomic weights.

The format of the book is especially satisfactory. The typography is excellent and alternate pages are usually left blank. The loose-leaf plastic binding is so designed that the manual will lie flat wherever it is opened. Pages can be easily removed and replaced without tearing.

This text should be given serious consideration by all who are interested in biochemistry.

D. A. W.

Essentials of Nutrition, Second Edition.

By HENRY C. SHERMAN and CAROLINE SHERMAN LANFORD, Columbia University. 442 pages, with 32 tables and 34 figures. Price $3.50. New York: The Macmillan Company, 1943.

PROMINENT among the advances in our knowledge of life and health have been the development of the science of nutrition and its influence upon the choice and use of food. Much of our knowledge of nutrition has been gained in the last generation. For instance, the discovery of vitamins, with studies on their occurrence in different kinds of food and calculations of the optimal and adequate amounts of the vitamins required, has been made within the last thirty years. This new edition offers readers an adequate up-to-date analysis of the essentials of nutrition. Its study will give the reader a complete picture of the entire field of nutrition.

The text begins with an introductory chapter indicating the status and aims of the science of nutrition. Then the "energy aspects" of foods, the proteins and their amino acids, the mineral elements and the vitamins are discussed at length. This book has been written carefully and in a style that is understandable to readers without much training in science. Seven pages of definitions of technical terms are included in the appendix to aid the reader who is unaccustomed to scientific terms. The appendix also includes tables showing the total calories and the amounts of protein, carbohydrate, fat, calcium, phosphorus, iron and vitamins C, B_1, G, A and D found in more than 200 common foods.

The relation of food to teeth is briefly considered in a chapter of fourteen pages. A comprehensive list of suggested readings on this subject is included. This short chapter will be of interest to dentists, although it is written for the general reader.

The book is easy to read and is filled with useful information about nutrition. A careful reading of this book will prove profitable to every one interested in the subject of nutrition.

M. K. H.

Drug Products: Labeling, Packaging, Regulations

By ARTHUR DONALD HERRICK. 462 pages. New York: Revere Publishing Company, 1942. Price $7.50.

THIS book is a comprehensive treatise on the Federal rules and regulations governing

the marketing of drugs, devices and cosmetics. There is a genuine need for such a book and it should be of value to all manufacturers, distributors, advertising agencies and other firms connected with the marketing of drugs, cosmetics and allied products. No special stress is placed on the dental aspects. Much use is made of the trade correspondence of the Food and Drug Administration and important judicial decisions are cited to explain enforcement policy. The useful appendix includes the Federal Food, Drug and Cosmetic Act (as amended), general regulations dealing with drug products, action on crude drugs and methods for testing antiseptics and disinfectants (1931). While the typography is not up to the highest standards, the language of the text is clear and the book is interesting and easily read.

D. A. W.

Partial Denture Construction

A Textbook Describing the Technics of Impression Taking and the Construction of That Type of Removable Partial Dentures Which Are Supported and Retained by External Attachments. By EDWARD KENNEDY, D.D.S., New York City, Formerly Consulting Dental Surgeon, with Special Reference to Postoperative Dental Prosthesis, Skin and Cancer Hospital, New York City. Formerly Demonstrator of Prosthetic Technics, Crown and Bridgework, Dental School of University of Pennsylvania, Philadelphia, Pa. Second edition. Revised and enlarged to 581 pages and 485 illustrations. Price $8.50. Brooklyn: Dental Items of Interest Publishing Company, Inc.; London: Henry Kimpton, 1942.

The first edition of this book was published February 1, 1928. The revision has the same text and cuts with very slight alterations and the author has added four new chapters, one on elastic impression materials and colloidal compounds, which describes the technic of impression taking with this material.

The chapter on "denture frames of stainless steel, vitallium and other metals" has twenty-two cuts showing completed cases in which vitallium has been used, but nothing on the technic of casting or handling the material, leaving this part to the commercial laboratories.

A brief chapter on obturators is an interesting account of personal experiences with cleft-palate cases, in which vitallium is advised as the material of choice because of its lightness and cleanliness.

The chapter on surgical appliances comprises twenty pages, which include forty-four descriptive cuts with accompanying articles.

The additions are too brief to be more than interesting and are not on a par with the material making up the first edition.

L. D. S.

The 1942 Year Book of Dentistry.

GEORGE W. WILSON, D.D.S.; HOWARD C. MILLER, D.D.S.; WALTER H. WRIGHT, D.D.S., Ph.D., and GEORGE R. MOORE, D.D.S., M.S. 799 pages, with 525 illustrations. Cloth. Price $3. Chicago: The Year Book Publishers, Inc., 1942.

THE 1942 edition of the popular Year Book of Dentistry series presents abstracts and summaries of 382 articles that appeared in current dental literature during the past year. The five editors have selected articles from dental and medical journals dealing with practical problems in dentistry, so that the book is filled with discussions of treatments, diagnostic procedures and operative procedures. Most of the articles were originally published in American dental journals, although American medical journals and British and South American journals are well represented. For obvious reasons, the European journals did not contribute articles this year.

The concise style used by the authors makes the book easy to read and understand. Occasionally, the reader will wish to refer to the original article for more complete details. The abstract published in the Year Book does not, of course, include more than a summary of the important parts of the article. However, the abstracts are usually informative and complete enough to be valuable. The authors have been careful to choose only articles that are authoritative and worthy of mention. Most dental readers will probably find interesting abstracts of articles missed in the original journal.

The book is carefully indexed and well

organized. Considering its modest price, the Year Book is a bargain for the dental practitioner.

M. K. H.

An Evaluation of Dental Health Literature.

By VERN D. IRWIN, Director, and NETTA W. WILSON, Educational Assistant, Division of Dental Health, Minnesota Department of Health. Paper, 50 cents; cloth, $1. 58 pages. St. Paul: Bruce Publishing Company, 1942.

COMPLAINTS against dental health literature, expressed repeatedly by those responsible for the teaching of dental health, have hitherto amounted to little more than "a voice crying in the wilderness." We have known for years that the literature in this field was poor, and, in some instances, definitely bad, but no one had the time or the initiative to do anything about it. Now, at last, a guide appears. In the words of the authors of this admirable little book, their survey of a considerable quantity of representative dental health literature is presented "as one means of helping find a way through a forest of antiquated notions, unproved assertions, half-true statements, glaring contradictions, and profitless technicalities." It is difficult to set a limit to the probable usefulness of this study. By the time the book has been in circulation for a few months, it may revolutionize dental health teaching and give new direction to health teaching in other fields.

Recognizing the inaccuracy and general poor quality of much of the literature used in conveying dental health "education" to the public, Dr. Irwin and Mrs. Wilson made a fairly exhaustive collection of such material. From hundreds of pamphlets, books and articles, they listed nearly 2,500 statements, a random sampling of which shows that, in the light of present knowledge, only about 32 per cent of the statements given to the layman as facts about dental health really are facts. The remainder of the statements are 24 per cent fallacious and 44 per cent controversial. The book actually presents a substantial number of the false, controversial and misleading statements found in current dental health literature. Many of them are shown to be so patently at variance with the known facts that is is rather a shock to find them actually printed by the thousand for distribution to unsuspecting children and adults.

Frank admission of failure is often the first step toward ultimate success. The purpose of this book is to use the recognition of past mistakes as a key to future improvement. Thus, the book goes far beyond destructive criticism. The chapter on "Adaptation of Dental Health Literature" points out numerous ways in which the educational material of the future can be made to meet adequately the needs of various groups of readers. Prospective producers of dental health literature are not only cautioned against the pitfalls that exist in their field of activity, but are also shown how to avoid them. The latter portion of the book abounds in suggestions for the production of dental health teaching material that will be accurate, interesting and practical. Such suggestions should be helpful to writers and teachers in all public health fields, particularly to dentists who are often at a loss as to what they should tell their patients and how they should convey needed information. Indeed, this is a book that is capable of serving dentists, teachers and public health workers in their task of educating the public, long after the current dental literature, with its regrettably high percentage of erroneous and controversial statements, has been abandoned and forgotten.

PETER J. BREKHUS.

Synopsis of Traumatic Injuries of the Face and Jaws.

By DOUGLAS B. PARKER, M.D., D.D.S., Associate Professor, Department of Oral Surgery, School of Dental and Oral Surgery, Columbia University. Cloth. 326 pages. 229 illustrations. St. Louis: The C. V. Mosby Company, 1942.

THE present conflict has indicated the need for a concise, but reliable manual on the immediate care of injuries to the face and jaws. This new work by Dr. Parker is a distinct contribution to this subject. The subject matter is divided into twenty chapters, beginning with the incidence of face and jaw injuries and devoloping the material to methods of treatment, immediate and late, of bone and soft tissue injuries. There is an adequate, well-illustrated section on methods

of fixing fractures of the jaws, including a discussion of the newer methods of skeletal fixation. The complications of fractures is briefly, but adequately covered. Each chapter has a short, pertinent bibliography. This volume should make an excellent textbook for dental students. The contents are brief and should serve as an adjunct to lectures on this phase of surgery. For the practitioner, this small book will provide the latest aspects of treatment of facial injuries in a readily assimilable form. It can be heartily recommended to all those interested in this important phase of dental practice.

Fractures of the Jaws and Other Facial Bones.

By GLENN MAJOR, B.S., A.M., M.S., Ph.D., D.D.S., M.D., F.A.C.S. Cloth. 425 pages; 225 illustrations. Price $7.50. St. Louis: The C. V. Mosby Co., 1943.

THE present conflict has increased the production of textbooks in many fields of medicine which have long lain fallow. The subject of jaw fractures is one of these fields. Within the past year, three books on this subject have been published in America. Several others have been published in England in the past two years. Each of these volumes purports to describe and discuss, with more or less infinite detail, the management and care of mandibular and maxillary fractures and associated injuries. This new book by the late Dr. Major does not differ essentially from its contemporaries in this field. The anatomy of the region is adequately discussed, the types of fractures seen are clearly described and many forms of treatment used by the author with success are enumerated. The greatest attention, and rightly so, is paid to intra-oral methods of fixation of these fractures. External methods of fixation by the newer methods of bone pinning are mentioned, but not discussed or described. Additional pertinent material is to be found in two additional chapters. The first of these, on radiographic technic, is contributed by L. M. J. Freedman. The second chapter, by Maj. Arthur Dick, discusses briefly the war aspects of jaw fractures. This volume presents a satisfactory summary of the technical factors of importance in the management of fractures of the jaws.

F. F. K.

BOOKS RECEIVED

Prepayment Plans for Medical Care

By FRANZ GOLDMANN, M.D., Associate Clinical Professor of Public Health, Yale University School of Medicine. Part I. Underlying Principles. Part II. A Comparative Study of Services and Costs of Five Plans. Joint Committee of the Twentieth Century Fund and the Good Will Fund; and Medical Administration Service, Inc. 1790 Broadway, New York. Price 25 cents.

Organization and Administration of Group Medical Practice

By DEAN A. CLARK, M.D., and KATHARINE G. CLARK. Joint Committee of the Twentieth Century Fund and the Good Will Fund; and Medical Administration Service, Inc. October 1941. Price 25 cents.

How to Organize Group Health Plans

By MARTIN W. BROWN, LL.B., KATHARINE G. CLARK and PERRY R. TAYLOR. Joint Committee of the Twentieth Century Fund and the Good Will Fund; and Medical Administration Service, Inc. February 1942. Price 25 cents.

Business Procedures

By PERRY R. TAYLOR. Compiled by the Joint Committee of the Twentieth Century Fund and the Good Will Fund and Medical Administration Service, Inc. November 1941. Price 25 cents.

Protesis A Placa

By P. SAIZAR. Volume II: Artificial Dentures, Base Materials, Hygiene and Conservation, Immediate Prosthesis, Surgical Preparation, History. Second edition, revised and enlarged. Progrental, Publisher, Buenos Aires, 1942.

ASSOCIATION ACTIVITIES

Contents

BUREAU OF PUBLIC RELATIONS

Filling Materials for Teeth 936

Dental Course for Nursing Schools in Kansas
Leon R. Kramer, D.D.S., and Evelyn Hannon, R.N., R.D.H. 939

Dental Pictorial 941

COUNCIL ON DENTAL THERAPEUTICS

Preliminary Report on Zinc Peroxide 942

Accepted Dental Remedies 942

Endocrines and Dentistry (Part III)
Isaac Schour, D.D.S., Ph.D., D.Sc., and Maury Massler, D.D.S., M.S. 943

MEMBERSHIP PAGE 951

COUNCIL ON DENTAL EDUCATION

Dental Students' Register, 1942 952

COMMITTEE ON LEGISLATION

American Medical Association *et al. vs.* United States 964

OBITUARIES

William H. G. Logan 968

Addison K. Parks 971

DEATHS 971

BUREAU OF PUBLIC RELATIONS

FILLING MATERIALS FOR TEETH*

INTRODUCTION

THE treatment of decayed spots in teeth is different from all other forms of health service because enamel, which covers the crown of a tooth, is the only tissue in the human body that cannot repair itself. The dentin, another of the hard tissues of the tooth, and which forms most of the interior of the crown and root, has only a very feeble ability to repair itself. Even this is restricted to the inner surface of the dentin next to the pulp, which is supplied with blood vessels. If enamel and dentin were able to repair themselves when injured, there would probably be no dentists as we know them. In other words, dental treatment is a highly specialized form of health service.

What, then, must the dentist do to restore decayed teeth? It is necessary (1) to remove the decayed portion; (2) to extend the cavity to those areas of the tooth that are comparatively immune to attack by decay, and (3) to fill the cavity with an inert material such as a metal, an alloy or a cement, or even synthetic resin, which has lately come to be used for this purpose. These materials, which will not decay, are considered, within the limitations hereinafter described, more or less permanent.

GOLD FOIL

Gold, when hammered into very thin sheets, can be welded in the cold state by the tapping of one piece of foil against another piece. This property of welding in the cold state was early utilized by dentists in filling cavities in teeth with gold foil, which was applied piece by piece, with a small mallet and plugger, to condense the foil to a solid bit of gold. At one time in dental practice, gold foil was almost the only material at the dentist's disposal for filling cavities in decayed teeth. In filling with gold foil, it is necessary to isolate the tooth with a rubber sheet so that neither saliva nor moisture from the breath will make a coating on the surface of the foil, which would prevent its being properly welded. The filling of large and complicated cavities in back teeth with gold foil is a long and fatiguing operation for both dentist and patient. It may require a sitting of several hours. For this reason, gold foil fillings are today seldom placed in large cavities. Their use is largely restricted to small cavities on the grinding surfaces of the back teeth, on the tongue surfaces and lip surfaces of the front teeth and on the proximal or side surfaces of the front teeth. It is generally conceded that a properly placed gold foil filling comes nearest to the ideal in fillings. Although it is the most nearly permanent filling, its use is gradually declining, and today possibly no more than 1 per cent of all fillings are of gold foil.

*The growth of public interest in dental health has resulted in a marked increase in requests for information on different phases of the subject. To meet this demand, the Public Health and Education Committee, now a committee of the Council on Dental Health, has authorized the preparation of a series of articles in pamphlet form, each article to deal with one of the dental questions most frequently asked by the public.

The current article, "Filling Materials for Teeth," by George C. Paffenbarger, D.D.S., can be obtained in reprint form at a nominal cost by addressing the Bureau of Public Relations, American Dental Association, 222 E. Superior St., Chicago, Ill.

The reasons for the decline in the use of gold foil are: (1) the development of materials and methods better adapted to the treatment of large cavities and of cavities in relatively inaccessible areas; (2) the comparatively long time consumed in placing fillings of gold foil; (3) the wear and tear on patient and dentist; (4) the relatively high cost of large fillings, and (5) the objection of patients to the appearance of gold in the front teeth. Because of the shortcomings of the gold foil filling, most of the fillings in front teeth are now made of silicate cement, a material greatly inferior to gold foil as regards length of service. (See section on silicate cement.)

AMALGAM

So-Called Silver Fillings.—An amalgam filling is composed of powdered alloy (containing, usually, silver, tin, copper and zinc) and mercury. When mixed, the alloy and mercury form a plastic mass, which later hardens just as cement does. The amalgam filling, although commonly called a silver filling, is only about one-third silver, the major constituent of the amalgam being mercury. Amalgam is the most widely used of all filling materials, approximately 70 per cent of all fillings being amalgam. It is an excellent filling material, recurrent decay occurring around amalgam even less frequently than around gold inlays. Amalgam is used primarily because its insertion is easier and quicker than that of the other so-called "permanent" filling materials. Teeth containing amalgam are usually discolored or darkened by the corrosion products from the amalgam. Fillings of amalgam and of gold or its alloys should never be placed in contact since the slight electronic reaction from this contact may result in corrosion of the amalgam. Since margins of amalgam fillings do not hold up well, recurrent decay might become rampant as food collected in the crevices if amalgam did not, it seems, exert a preventive action, as previously stated, less decay occurring around it than around any other commonly used filling material. This reputation as a tooth saver contributes to making amalgam the most widely used filling material. It should not be used in the front teeth, because it tarnishes easily and frequently discolors the teeth.

SILICATE CEMENT

At the turn of the century, a cement was invented in Germany which could be colored to look like the teeth. This cement was a special kind of powdered glass which, when mixed with phosphoric acid diluted with water, set or became hard. Such a cement, in reality a silicate cement, is commonly and erroneously call synthetic porcelain. It could be mixed and placed directly in the cavity, and then could be made to follow the shape of the tooth before the cement hardened. Cements of this type have, during the last thirty-five years, almost replaced gold foil in the filling of cavities in the front teeth. In fact, almost 8 per cent of all fillings are now made of silicate cement, because of the lifelike appearance of the cement filling when first inserted and the ease with which it can be inserted. Unfortunately, silicate cement shrinks and is relatively soft and soluble. The average effective life of a silicate cement filling is estimated to be about 5 years. Usually, by this time, the filling will be darker than when first inserted and will have dissolved out of the cavity, either partially or completely. There are numerous instances of a silicate cement filling lasting twenty-five years or more, but a service of such length is the exception rather than the rule.

OTHER TYPES OF CEMENT FILLINGS

Cement fillings have one distinct advantage over metallic fillings in that they are very poor conductors of heat and cold, while metals are good conductors.

In deep cavities, it is often necessary to place a shallow cement filling to insulate the soft tissues in the center of the tooth (the so-called pulp, consisting of nerves, blood vessels, connective tissue, etc.) from the metallic filling so that extremes of heat and cold will not be readily transmitted to the center of the tooth. The most effective cement for this purpose is generally considered to be a mixture of powdered zinc oxide and oil of cloves, because it is the least irritating to the inner soft tissues (the pulp). It is too soft to be used as a filling material except to hold a medicament in place or to protect the cavity temporarily. Another cement, the powder of which is usually composed of zinc oxide and magnesium oxide, and the liquid of which is a water solution of phosphoric acid, is used primarily as a cementing medium. It is used chiefly to cement bands, crowns, inlays and other dental appliances to the teeth.

INLAYS OF GOLD ALLOYS OR PORCELAIN

In 1907, an American dentist invented a revolutionary method of restoring lost tooth structure with gold or gold alloys, which were cast in the desired shape and then cemented to place. The method consists essentially of preparing a cavity without any undercuts so that a wax pattern of missing sections of a tooth can be carved to form and then withdrawn from the cavity without distortion. The wax pattern is then surrounded by plaster of Paris, powdered silica and water, a mixture that hardens. On heating, the wax is vaporized, a space remaining in which molten gold alloy is cast. The resultant casting, a metallic replica of the wax pattern, is cemented in the cavity of the tooth. A gold inlay, when properly made, makes an excellent filling. If much tooth structure is missing, the gold inlay is the best available type of filling, and it would be more widely used except for the time-consuming process of making it. More than 20 per cent of all fillings are gold inlays.

A porcelain inlay is made by fusing powdered porcelain in a tray of thin platinum foil. After the porcelain is fused, the platinum foil is stripped from the porcelain and the filling is cemented to place in much the same manner as a gold inlay. Porcelain is used primarily because it resembles dental enamel. Generally, it cannot be used as a small filling on surfaces of teeth where biting or crunching is done because the porcelain is brittle and will fracture; but when the entire crown of a tooth is to be restored, porcelain can be used very successfully. In the front teeth, it is a nearly ideal restoration medium.

RESINS

Lately, some of the synthetic resins have been used as filling materials, but only one of those now available, methyl methacrylate resin, seems promising. It may replace to some extent the porcelain in inlays and the silicate cement as a filling since it has a natural appearance and is much tougher than either fused porcelain or the cements. At the present time, its use is in the experimental stage. Only time will tell whether it is practicable.

COMMENT

The type of filling material selected by the dentist for use in a cavity depends on a number of conditions, such as the location and extent of the cavity, the health of the supporting bone and soft tissue and the general health and the economic status of the patient.

In connection with the fee for dental service, it should be noted that the cost of the filling materials is by no means the major item. The time and training required to provide the service determine the fee to a large extent. That the tooth should be repaired when the cavity is extremely small should aways be emphasized; for the repair is then simply and quickly handled. Comparatively little

time and material are consumed and the fee will be corresponding small. Rarely can any one not a dentist detect a cavity that is just beginning to form. Early detection and treatment of decay constitute preventive measures against caries.

For several years, the American Dental Association, through its Research Commission, has been cooperating with the Federal Government at the National Bureau of Standards in testing the various types of filling materials and in establishing specifications for them. At this bureau, government scientists and research associates of the American Dental Association are constantly testing different trade brands of filling materials to determine whether they comply with the requirements of the specifications of the Federal Government or of the American Dental Association. Lists of such materials as are found to comply with the specifications are published in the JOURNAL OF THE AMERICAN DENTAL ASSOCIATION in order that dentists may know what materials are satisfactory. This cooperative research program has included investigation of the methods of using filling materials, so that the effect of different methods upon the properties of the materials may be known; for it is possible not only to abuse, but also to ruin a good material by an improper technic in handling it. The ultimate purpose of this program is to so facilitate the proper use of suitable filling materials that the best possible dental health service may be rendered.

DENTAL COURSE FOR NURSING SCHOOLS IN KANSAS

LEON R. KRAMER, D.D.S., M.P.H., and EVELYN HANNON, R.N., R.D.H.,
Topeka, Kan.

MANY nurses, upon entry into the field of public health, express their regret at having received little or no training in regard to oral diseases and the dental phases of health.

The desire to do something about this situation was bolstered by the completion of the "Public Health Nursing Curriculum Guide" prepared by the Joint Committee of the National Organization for Public Health Nursing and the United States Public Health Service, in 1942. In this guide, "Oral Health" is an integral part of the course recommended for postgraduate training of public health nurses.

The matter was brought to the attention of the officers of both the Kansas State Dental Association and the Kansas League of Nursing Education. It was decided that the Dental Division of the Kansas State Board of Health should conduct a survey of the thirty-eight accredited nursing schools in the state in order to get a true picture of the status of oral health instruction in the curriculum of the various schools and also to determine the reaction of school directors relative to the inclusion of a dental health course in their curriculum for nurses' training.

Thirty-five of the thirty-eight superintendents of nurses to whom questionnaires were sent filled out and returned them. Each questionnaire was given an identification number and the answers to the questions were set up on a chart.

This chart shows that fourteen of the thirty-eight schools have a course on

From the Kansas State Board of Health.

oral health, courses varying in number of lectures from four to twelve. The length of lecture periods varies from forty to sixty minutes. The courses in twelve schools are conducted by dentists, in one school by a nurse and in another by a county health officer, a physician. Seven schools include dental questions in their examinations. One school intends to include an oral health course in 1943.

In answer to the question, "Do you think that a short course in dental health would be a worthy contribution to the nurses' educational preparation?" the reaction was 100 per cent favorable.

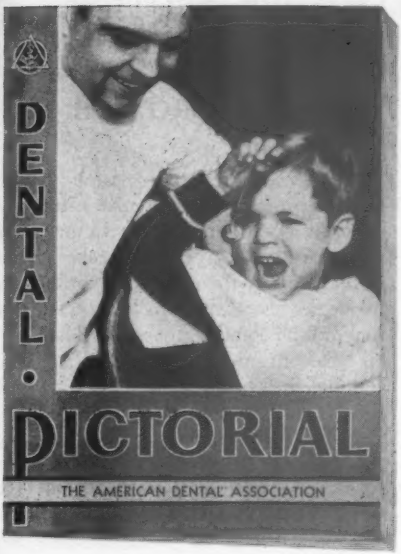
The comments in regard to the course made by superintendents of nurses are exceptionally interesting. They reveal that the superintendents are wide awake to the importance of dental care to general health. They emphasize the importance of training nurses to have an understanding and appreciation of dental care, not only in relation to the care of the sick, but also in relation to their own health and to public health. All express a desire for a more intensive course of training for nurses in the field of dental hygiene. However, several brought out the difficulties involved in the introduction of a new course on this subject or in the expansion of a course already being given. Foremost among these difficulties are the problems of obtaining competent instructors and of finding time for the course in the already crowded schedule of the nurses' training program.

When the results of the special study were presented to officers of the Kansas State Dental Association, they voiced the desire to cooperate with the Kansas League of Nursing Education if the league wished to take steps to include a course on oral health as an integral part of nurses' training. At a meeting of the League at Wichita in October 1942, the proposition was presented and a resolution was passed stating that the League of Nursing Education would cooperate with officials of the dental profession to plan further steps in the proposed activity.

At the spring meeting of the Kansas State Dental Association, the proposition will be placed before the assembly for the purpose of developing the mechanics for correlating the activities of the dental and nursing organizations, and to select committees to work out a standard course for nursing schools. It is planned to suggest that provisions be made to include dental questions in the state board examinations for nurses wishing to practice in Kansas.

It is also planned to provide the various dentists in the state who will present the oral health courses in the nursing schools with a lecture course on the fundamentals of teaching. Should there be localities in which there are no available doctors of dental surgery to give the course, the Division of Dental Hygiene will make the necessary provisions.

The accredited schools of nursing in this state graduate between 500 and 600 nurses each year. To have each of these nurses receive training in the principles of oral health should contribute greatly to the number of persons educated in matters pertaining to the control of the ravages of dental disease in Kansas.



DENTAL PICTORIAL

Dentistry's Publication for the Public

Question: *What is Dental Pictorial?*

ANSWER: *Dental Pictorial* is an official publication of the American Dental Association. It is an educational magazine, pictorially edited for the layman. It contains material for the school child, teacher and parent at the level of literacy of the average American family.

Question: *Why should I subscribe to Dental Pictorial?*

ANSWER: To further dental health education in your community, particularly in the home and the school. In this way, you lay the educational groundwork for the coming postwar adjustment period.

Question: *Where should I place Dental Pictorial?*

ANSWER: A. In your reception room.
B. In the homes of patients.
C. In the school, library and health center.

Question: *What is the recommended plan for using Dental Pictorial?*

ANSWER: It is recommended that you have *Dental Pictorial* mailed to a list of patients. You make out and send this list to *Dental Pictorial,* American Dental Association, 222 East Superior St., Chicago. The publication is mailed from Chicago to your patients. It is also recommended that *Dental Pictorial* be subscribed to for the reception room and that its information be used in conversation with the patient in the chair.

Question: *Do I need to send in postage?*

ANSWER: No, postage is included in the subscription price.

Question: *Should I send Dental Pictorial to all my patients?*

ANSWER: It is recommended that you send it to a selected list of patients, preferably parents, as *Dental Pictorial* has a strong family appeal. It is well to bear in mind in having *Dental Pictorial* mailed to your patients that it is read not only by the patient, but also by the friends, relatives and neighbors of the patient. Even if you send *Dental Pictorial* anonymously, you are rendering a service that will be greatly appreciated by the patient.

Question: *How do I get Dental Pictorial and pay for it?*

ANSWER: Many of the leading dental dealers have already agreed to take subscriptions and handle payments. We suggest that you discuss this with your dealer. He will gladly cooperate with you.

Turn to page A-11 for further information on *Dental Pictorial.*

COUNCIL ON DENTAL THERAPEUTICS

PRELIMINARY REPORT ON ZINC PEROXIDE

THE numerous requests for information in regard to the usefulness of zinc peroxide in dental therapeutics, particularly in the treatment of Vincent's infection and of infected postextraction wounds (so-called dry-sockets), motivated an investigation of the evidence presented to date on the dental usefulness of this compound. The available evidence is notably scant. No controlled clinical tests or observations have been made in the field of dental therapeutics and the reports made to date cannot be scientifically evaluated. The fact that brands of zinc peroxide are admitted to New and Nonofficial Remedies by the American Medical Association Council on Pharmacy and Chemistry indicates that the compound has merit in certain fields of therapy. However, because of differences in their etiology and pathologic processes, certain dental diseases may not be equally amenable. The Council will continue to review evidence bearing on this problem and will consider brands of zinc peroxide for inclusion in A.D.R. whenever adequate acceptable evidence in support of claims for usefulness in dental therapeutics is presented.

DONALD A. WALLACE, *Secretary.*

ACCEPTED DENTAL REMEDIES

The Council on Dental Therapeutics of the American Dental Association announces the inclusion of the following article in the list of Accepted Dental Remedies.

DENTIFRICES*

Horn's Tooth Powder: Composition: See Stevens-Wiley Tooth Powder (A.D.R. Ed. 8, p. 113).

Manufactured by the Stevens-Wiley Mfg. Co., Inc., Philadelphia, Pa. Distributed by Cook Coffee Company, Cleveland, Ohio.

Admission of a product to the list of Accepted Dental Remedies does not imply a recommendation. It means that the product and the methods by which it was marketed at the time of consideration were not found to be in violation of the Council's published rules. Accepted products are reconsidered periodically. The files of the Council contain information on many drugs and dental cosmetics. All information is available upon request and inquiries are welcomed. A postal card will bring a prompt reply.

DONALD A. WALLACE, *Secretary.*

*A.D.R. Ed. 8, p. 102.

ENDOCRINES AND DENTISTRY*

PART III

(Continued from May, page 773)

ISAAC SCHOUR,* D.D.S., Ph.D., D.Sc., and MAURY MASSLER,† D.D.S., M.S., Chicago, Ill.

THE PARATHYROIDS

Origin and Location.—The parathyroids are usually four ovoid bodies about 8 by 5 mm. in size, located at each corner on the posterior surface of the thyroid. (Fig. 1.) Accessory parathyroid glands are not uncommon in man.

Function.—The parathyroids secrete a hormone the function of which is to maintain the calcium-phosphorus equilibrium in the blood. Whenever there is a hypocalcemia, calcium is mobilized from the bones through the mediation of the parathyroids. The parathyroids thus play an important rôle in calcium metabolism. Growth is little, if at all, affected by abnormal function of the parathyroid glands.

Hypoparathyroidism.—Congenital absence of the parathyroid glands is not usual. Experimental complete ablation is also difficult because of the presence of accessory gland tissue and the small size and the wide distribution of the glands.

A hypofunction of the parathyroid glands results in a marked hypocalcemia, with resultant increased excitability of the nervous system (parathyroprivic tetany). It should be remembered, however, that tetany is due primarily to the hypocalcemia and that the latter may be caused not only by a deficiency of the parathyroid secretion, but also by an alkalosis or failure in absorption of calcium due to a deficiency of calcium and phosphorus in the diet, an overabundance of phosphorus or a deficiency in vitamin D. (Wolf.)

Formation and calcification of enamel and dentin: In human cases of parathyroprivic tetany occurring in infancy, enamel hypoplasia and disturbances in the calcification of dentin are seen in the tissues calcifying at that time. Humphreys (1939) reported histologic changes in the dentin of a woman who had suffered from parathyroprivic tetany since the age of 12. The dentin forming and calcifying during the parathyroprivic period showed changes similar to those seen in the dentin of parathyroidectomized rats. The incremental stratification was accentuated and showed alternate disturbances in calcification. In addition, pulpal inclusions gave evidence of disturbances in apposition.

On the other hand, Humphreys (personal communication) found no changes in the teeth of a patient whose parathyroids were accidentally removed in thyroidectomy at the age of 23. These negative findings again show that disturbances in calcium metabolism to which growing and calcifying dentin responds with remarkable sensitivity will not affect the dentin that was formed and calcified previous to the disturbance.

Craniofacial development: The development of the craniofacial skeleton and the jaw is apparently normal. No disturbance in eruption has been reported, although an open bite in the anterior region occurs if hypoplasia is present. (Fig. 19.)

Experimental hypoparathyroidism: The primary effect of parathyroidectomy is a lowering of the blood-calcium level and an elevation of the blood-phosphorus. The developing enamel and dentin show alternate irregular and accentuated zones of undercalcification and overcalcification. Fully formed enamel and dentin show no changes. Disturbances in appositional growth occur only in very severe cases when enamel hypoplasia and vascular inclusions of the dentin are manifest. (Schour, Chandler and Tweedy, 1938.) (Fig. 20.) The eruption of the teeth does not seem to be appreciably altered.

Effects of replacement therapy: Replacement therapy in parathyroidectomized rats results in a normal calcification of the enamel and dentin calcifying during the period of treatment, but does not confer normality on

*This series of articles is available in bound form. Send requests to Bureau of Public Relations.

the structures that were formed in the absence of parathyroid function.

The possible close relationship between vitamin D and parathyroid function is suggested by the fact that administration of vitamin D alone to parathyroidectomized rats is effective in increasing calcification. (Schour, Tweedy, Chandler and Engel.)

Absence of resorption in enamel and dentin: The enamel and dentin of the incisors or molars formed and calcified before the experimental period show no changes, even when the experimental parathyroprivic condition is aggravated by repeated fasting or by repeated pregnancy and lactation. In spite of the severe drain upon the calcium reservoir, resorption is absent and no calcium withdrawal occurs from the enamel and dentin. (Schour, Chandler and Tweedy, 1937.)

Hyperparathyroidism.—The increase in parathyroid hormones results in an immediate rise in serum calcium and an increase in excretion of calcium. The mechanism is not well understood. Three theories have been advanced, by Greenwald (1926), Albright and Elsworth (1930) and Selye (1932). (Wolf.)

The rise in serum calcium is accomplished by the mobilization of calcium from the bones. The calcium is liberated and made available to the blood stream by direct osteoclastic action (bone resorption), and a generalized resorption of bone (osteitis fibrosa generalisata) and fibrosis (osteitis fibrosa cystica) results. The generalized and marked osteoclasis occurs at the sites of the most active bone deposition, since, in these areas, the cellular and vascular elements are most active and abundant. The resorption, therefore, is localized for the most part in (1) spongy bone trabeculae near the epiphyseal plates of the long bones, (2) the diploe of the cranial bones and (3) the alveolar bone of the jaws. (Jaffe, 1933.)

It must be emphasized that the teeth do not take part in this process since the enamel and dentin are avascular and acellular and the permanent teeth do not resorb. Thus, although teeth and bone are both calcified tissues, they are physiologically dissimilar.

Changes in the jaws: Strock examined a number of patients suffering from hyperparathyroidism and described the following changes in the jaws:

1. Intra-oral x-ray films show a marked change in the architectural pattern of the trabeculae, which become very fine and closely meshed, presenting a "ground-glass" appearance (as in osteomalacia).

2. The entire mandible becomes osteoporotic and many cyst areas (unilocular and multilocular) are found in the alveolar process.

3. The entire jaw becomes so depleted of calcium and so soft that it can be molded with the fingers.

4. As a result of these changes, a definite malocclusion develops quite early. In fact, the first sign of the disease is often a sudden drifting of the teeth for no apparent reason (as occurs also in diffuse alveolar atrophy). A definite spacing of the teeth occurs, usually with a mandibular prognathism.

5. In striking contrast to this picture are the teeth. They are well calcified, having been in no way affected by the tremendous calcium withdrawal from the bone of the jaws. They stand out roentgenographically in marked contrast to the bone. (See also Albright, Aub and Bauer.) (Fig. 21.)

6. The teeth are not loose (as in diffuse alveolar atrophy). In fact, extraction is said by Strock to be difficult. Borg, on the other hand, reports that the teeth are loose, but tighten on removal of the parathyroid tumor.

7. Caries is rare and, if active before the onset of the disease, appears to diminish during its course.

8. Fifty per cent of cases show giant-cell tumors of the jaws.

Experimental hyperparathyroidism: The clinical observations are well supported by experimental findings.

Calcification of dentin: The primary effect of injection of parathyroid extract in the normal rat is a rise in the blood-calcium level and a corresponding hypocalcification of the dentin. Immediately following is a secondary reaction, a return of the blood calcium to its normal level and development of a corresponding hypercalcified stripe in the dentin. (Schour, Tweedy and McJunkin.) (Fig. 22.)

Calcification and resorption of bone: The alveolar bone shows an abnormal increase in osteoclasts, and, in addition, a fibrous change of the bone marrow, presenting as well the changes characteristic of osteitis fibrosa seen in the long bones. (Schour, Tweedy and

McJunkin.) It should be noted that while the alveolar bone is almost wholly resorbed, the enamel and dentin are unaffected. In fact, the dentin forming and calcifying during the experiment appears on the whole to be hypercalcified. The changes are of special interest because they reveal in a striking manner the physiologic differences between enamel and dentin on the one hand and bone on the other. (Fig. 21.)

In prolonged hyperparathyroidism in rats, Burrows reports a change in the alveolar bone of molars from a spongy to an almost compact structure. This effect is, however, quite different from that seen in acute hyperparathyroidism, in which a marked osteoporosis occurs. (Mortimer.)

In view of the conclusive findings that enamel and dentin, unlike bone, do not show resorption in hyperparathyroidism, it is surprising that, in the literature, the statements persists that the teeth are "decalcified" in hyperparathyroidism. The teeth may become loose as a result of the active resorption of the alveolar bone, but the teeth themselves remain well calcified.

Growth *per se* and the eruption of the teeth do not seem to be disturbed.

THE PANCREAS

The pancreas, like the gonads, serves both an exocrine and an endocrine function. The endocrine function is concerned with carbohydrate and fat metabolism and is accomplished through the islands of Langerhans, which secrete insulin. Insulin regulates the storage of glycogen in the liver and muscles and also plays a rôle in its mobilization and combustion for use as an energy agent. Its chief function is to maintain a normal level of blood sugar.

Diabetes (Hypoinsulinism).—Diabetes mellitus, usually a result of the hypofunctioning of the islands of Langerhans, is characterized by a disturbance in carbohydrate, fat and protein metabolism. It results in an increase in the blood sugar, cholesterol and acetone bodies, and an increase in secretion of urine, of a high specific gravity and containing glucose and acetone bodies. (Wolf.)

Juvenile diabetes: The disease in children is often insidious and asymptomatic, the diagnosis being made only during the course of a routine urine test or after coma.

The child is apt to be ahead of the average in physical and mental development. However, this can be correlated with the fact that hypoinsulinism occurs more frequently in the broad, endomorphic type in whom development is normally above the average. (Goldzieher.) As far as can be determined, no marked effect on body growth is present in juvenile diabetics.

Effects on the dental apparatus: The teeth and jaws of diabetic children are normally developed. (Ziskin and Siegal; Brauer and Bahador.)

Rutledge (1940) reports periodontal disturbances (non-specific gingivitis and marginal, vertical and horizontal atrophy) in 80 per cent of the juvenile diabetics that he examined. This finding is in accordance with the general lowering of tissue vitality in severe diabetes. However, with treatment (even with only partial control), most investigators report no abnormal findings in the periodontal tissues.

Caries: The increased excretion of sugar in diabetics is correlative with an increase in the incidence of dental caries. This is not surprising since it has been proved that, in hyperglycemia, carbohydrates appear plentifully in the saliva, and thus act locally to produce caries. It is also well established that a diet low in carbohydrates will arrest the progress of dental caries. (Boyd.) This finding is in accordance with the facts known as to the rôle of carbohydrates in the production of caries.

Adult diabetes: Growth and development are, of course, not at all affected in adult diabetics, but periodontal disease has been described frequently in this group. The age factor, however, is as important as the disease entity, since both hasten and accentuate the breakdown of the periodontal tissues by a lowering of tissue vitality and resistance.

Hyperinsulinism.—The effect of hyperinsulinism on growth in general or on the dental apparatus and its effects on tissue maintenance and repair have not yet been intensively studied, since the clinical entity has only recently been recognized. A correlation between relative hyperinsulinism and health has been made in the study of ectomorphic constitutional types, a study still in its infancy. (Goldzieher.)

THE THYMUS

The influence of the thymus upon the den-

tal apparatus is not well known or understood. The present state of knowledge on the thymus is highly controversial, even to the point that, as has recently been stated, the thymus is not regarded as an endocrine gland.

Rowntree's experiments and results with Hanson's extract of the thymus could not be repeated and judgment on the effects should be reserved until further work is done.

The reader is referred to Wolf's "Endocrinology in Modern Practice" for a further consideration of this gland.

THE PINEAL BODY

The rôle of the pineal body in the human economy is still doubtful. Rowntree and his associates have shown a relationship between the pineal gland and growth and genital development. Here again, judgment must be reserved until further work is done.

The presence of a pineal tumor has been known to result in precocious mental, genital and somatic changes similar to those already described under the adrenogenital syndrome, precocious puberty and hypergonadism.

ENDOCRINE THERAPY IN DENTISTRY

While recognizing the profound influence of the endocrines on the body economy and the dental apparatus, it must be pointed out that such conditions as nutrition and heredity are equally important. Clinicians have occasionally yielded to the temptation to invoke the endocrines when confronted with a puzzling clinical condition.

It is not surprising, therefore, that, in view of our limited knowledge of the cause of caries, periodontal disease and malocclusion, and the consequent great number of theories concerning these conditions, the endocrines have come to be implicated. The rôle of the endocrines in the production of dental disease is not yet definitely established. For the most part, statements in the literature that relate endocrine dysfunction etiologically to dental disease are not supported by substantial clinical or experimental evidence and represent at best a "hunch" on the part of a particular investigator.

Periodontal Disease.—The view that a large percentage of periodontal disease is a result of endocrine disorders is not yet justified. When a patient presents this condition and a careful analysis is made, endocrine dysfunction can rarely if ever be proved. There are many conditions, both local and systemic, other than endocrine dysfunction that are associated with periodontosis (trauma and loss of tissue resistance due to systemic disease, dietary conditions or infections).

Although a relationship between endocrine dysfunction and periodontal disease can be established, as in uncontrolled diabetes, untreated hypothyroidism or hyperthyroidism, or hypopituitarism or hyperpituitarism, in our investigations it is not evident in more than 50 per cent of the cases studied; i.e., in no more than in any non-endocrine group. The procedure in such cases is treatment of the primary disease, as well as specific treatment of the condition.

Caries.—Caries is so widespread that the coincidence of caries with a given endocrine dysfunction can be high, and yet have no causal relationship. The impression of some that a high incidence of caries occurs in cretinism and in pregnancy has been repeatedly disproved upon further careful clinical analysis. The impression that an exacerbation of caries occurs during puberty is suggestive, but as yet no objective evidence of a causal relationship has been reported.

Malocclusion.—The normal occlusion of teeth is often interfered with when the growth of the jaws is disturbed in severe endocrinopathies. However, the supposition that malocclusion in general is caused by endocrine dysfunction is untenable. No endocrinopathy can be demonstrated or even suspected in the vast majority of cases of malocclusion. Malocclusion is far more often due to local, developmental and genetic conditions other than endocrine in nature. If a given case of malocclusion is the result of an endocrine disturbance, the treatment indicated is one that will correct the primary endocrine disorder, the diagnosis of which lies in the realm of the internist. In case he is successful in curing the primary endocrine disturbance, the orthodontic correction of the secondarily induced malocclusion may be automatically facilitated.

Responsibility of the Dentist.—The dentist has the opportunity to recognize in his patients facial and oral manifestations that are of possible endocrine origin and the responsibility for referring them to the internist for further diagnosis and treatment if indicated.

CONCLUSIONS BASED ON INADEQUATE EVIDENCE	CONCLUSIONS BASED ON AVAILABLE EVIDENCE
All of the phenomena of tooth decay, including resorption and erosion of the surface of crown and roots, are endocrine manifestations. (Hardgrove.)	Tooth decay is a result of bacterial action, and while all the factors in the production of caries are not known, it is not primarily an endocrine problem.
. . . and the extract of the parathyroid, when it can be safely used, are the medical means of immediate arrest and prevention of decay. (Hardgrove.)	There is no evidence that the administration of the parathyroid extract will in any way influence dental decay.
Teeth that show rapid decay are hungry for calcium and phosphorus in the proper relation. (Hardgrove.)	Chemical analysis of the unaffected areas of decayed teeth reveals no significant differences from normal teeth in calcium and phosphorus content.
The precipitation of large calcific deposits from the saliva upon the teeth is induced by chemical reactions initiated by the endocrine glands. (Hardgrove.)	The exact cause of salivary calculus is not known. The salivary glands are not endocrine glands.
The more nearly normal the endocrine influence, the more nearly normal will be the formation of the tooth and the more likely it is to be free from pits. (Hardgrove.)	Occlusal pits and fissures are normal anatomic characteristics, phylogenetically determined, and therefore not altered by endocrine or other dysfunction in the individual.
If the baby arrived in this world free from endocrine defects, the orthodontists would lose from one-third to one-half their clients. (Hutton.)	Orthodontic cases of possible endocrine origin are rare.
Calcium drain is especially evident in the teeth of mothers, a phenomenon long recognized in the aphorism "for every child a tooth." (Hoskins.)	The enamel and dentin, unlike bone, are not a reserve source of calcium. Statistical investigation has indicated no significant difference in the incidence of caries in pregnant and non-pregnant women of corresponding age.
The size and shape of the particular teeth are diagnostic signs of specific endocrine disturbances. (Marinus; Berman.)	The size of the crown is largely determined by the dentino-enamel junction, which is established early in life, in most cases before endocrine dysfunction has begun.
Central incisors are small in hypopituitarism; lateral incisors are affected in gonadal dysfunction; the cuspid is the adrenal tooth. Small or missing upper lateral and disproportionately large central incisors may indicate a persisting thymus. (Wolf.)	The physiology of the teeth is the same, regardless of their class. The clinical crown was here confused with the anatomic crown.
Decalcification of teeth was a frequent sign of hypercalcemia. (Engelbach.)	Decalcification of enamel occurs only through local action by acids. It cannot occur by systemic means.

The diagnosis should, however, be based on more than the oral indications, since it is unlikely that an endocrine dysfunction would be manifested only in the oral tissues. In view of our limited knowledge and the insufficient purity of the available extracts and the possibility of their harmful effects in doubtful conditions, conservatism is strongly indicated. It is safer to take the view that in oral manifestations suggesting an endocrine dysfunction which cannot be confirmed in other structures, treatment should be confined to dental measures. If the internist finds further evidence of endocrine dysfunction, the patient should be treated both by the dentist and by the physician. The welfare of the patient will be served best by the proper coordination of dental and medical treatment.

Basis for Conclusions Concerning the Relationship Between the Endocrines and the Teeth.—It is unfortunate that, from time to time, misinformation on this subject appears in the dental literature, with complete disregard of the scientific evidence and reflecting a lack of knowledge and understanding of the anatomy, histophysiology and pathology of the dental apparatus. Such misinformation is especially harmful when it leads to unwarranted endocrine therapy in dentistry and to a false sense of security on the part of the patient and the dentist. For example, the conclusion in a recent paper that "calcium, iodine and vitamins A, B, C and D, and the extract of the parathyroid, when it can be safely used, are the medical means of immediate arrest and prevention of decay" (Hardgrove, 1942) is not founded on actual data submitted by the author. It reminds one of the old shot-gun prescription method and cannot lead to constructive aid in the treatment of dental caries.

The accompanying table gives a few selected and abstracted statements illustrating the kind of misinformation that has been published in the literature and that must not be allowed to go unchallenged, in contrast to selected statements based on available evidence. Some of the facts that disprove the misinformation appearing in the literature have been presented elsewhere in this paper.

SUMMARY AND CONCLUSIONS

1. The recording qualities of the teeth and bone permit a careful developmental and histologic analysis of the influence of the endocrines on the growth and development of the teeth, the jaws and the facial skeleton and thus contribute to a better understanding of the functions of the endocrines.

2. Knowledge of the relationship between endocrines and the dental apparatus is of twofold value. It aids in early diagnosis and clarifies normal processes of growth, development and metabolism.

3. The endocrines exert a profound influence on the formation, calcification and eruption of the teeth and regulate the expression of the growth pattern of the jaws, face and cranium.

4. The effect of a given endocrine disturbance varies with the different periods of the life span. The earlier the disturbance, the more profound the results.

5. The employment of endocrine therapy in dentistry *per se is* not justified. There is no evidence that alterations in endocrine function give rise to oral or dental symptoms without producing other systemic symptoms. When systemic manifestations are present, the responsibility for endocrine therapy rests with the physician.

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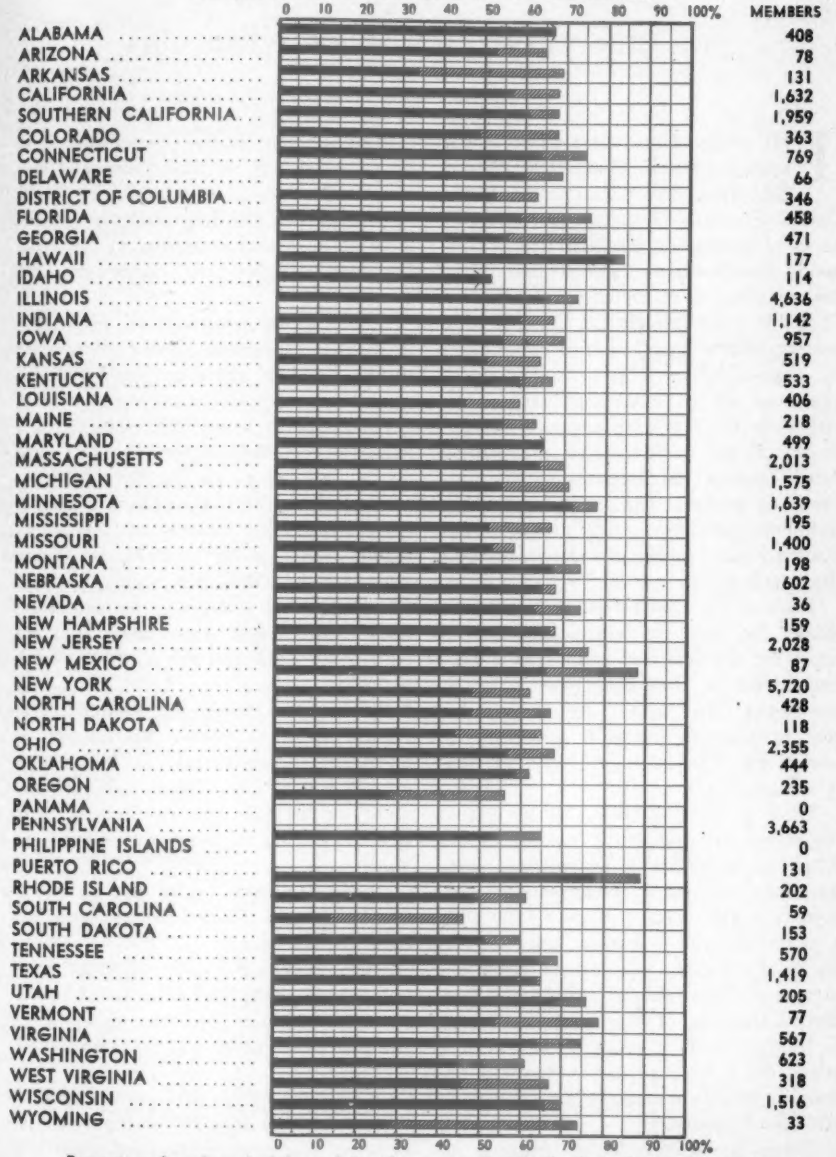
Membership Page

PERCENTAGE OF DUES RECEIVED IN CENTRAL OFFICE AS OF APRIL 30, 1943, AS COMPARED TO 1942 MEMBERSHIP



Percentage based on dental population figures supplied by the State Society Secretaries.

1943 percentage

1942 percentage

COUNCIL ON DENTAL EDUCATION

THE DENTAL STUDENTS' REGISTER, 1942

THE series of statistical tables issued annually by the Council on Dental Education under the caption of the Dental Students' Register presents evidence of interesting trends in dental education and licensure. The several tables are compiled as of October 15, 1942.

Table 1 on *Enrollment* shows a total undergraduate enrollment as of October 15, 1942 of 8,847. This is an increase of 492 over the previous year and is the largest in the last sixteen years. The increase of 492 is distributed as follows: 226 Freshmen; 86 Sophomores; 67 Juniors; 113 Seniors. The grand total of enrollment including special, graduate and postgraduate students and dental hygiene students is 9,276.

Table 2 on *Comparative Enrollment* shows the total undergraduate enrollment for the last ten years. The lowest enrollment in that time was 7,160 in 1933-1934. The largest enrollment this year in a single school is 561 and the lowest, 64. The average in the 39 dental schools is 227.

Table 3 on *Pre-Dental College Training* shows the pre-dental training of the 8,847 undergraduates as follows: with less than 2 years, 3 (hold-overs); with 2 years, 4,338; with 3 years, 1,740; with 4 years without a degree, 366; with a bachelor's degree, 2,298; with other degree, 102. This table also shows the pre-dental training of the 2,702 Freshmen as follows: with 2 years, 1,236; with 3 years, 675; with 4 years without a degree, 127; with a bachelor's degree, 645; with other degree, 19.

Table 4 on pre-dental training of *Graduates* in 1942 shows that there were 1,784 graduates for the year ending June 30, 1942 with pre-dental training as follows: with less than 2 years, 13; with two years, 826; with 3 years, 350; with 4 years without a degree, 74; with a bachelors's degree, 481; with other degree, 40.

Table 5 on comparative pre-dental training of *Graduates from 1936 to 1942* shows a steady increase from 1936 to 1941 from 18 per cent to 32 per cent of graduates with pre-dental training of a bachelor's or other degree. In 1942 there was a decrease to 29 per cent.

Table 6 on the *Geographical Distribution* of the 8,847 undergraduates shows students from every state in the Union and 77 from U. S. possessions, 37 from Canada and 57 from other foreign countries. The largest enrollment is 1,851 from New York and the smallest 4 from Nevada.

Table 7 on enrollment in *Schools of Dental Hygiene* shows 16 schools in operation (12 in dental schools) with an enrollment of 387. Three hundred and sixty-one degrees or certificates were granted during the year ending June 30, 1942.

Table 8 gives a list of the 39 dental schools in the United States with the names of the deans.

Table 9 gives the dates when the present classes under the accelerated schedule will graduate and the dates when the next new classes will enter and graduate.

Table 10 gives the percentages of failures in state dental licensing examinations for the three years 1939, 1940 and 1941, by states and by dental schools.

TABLE 1.—TOTAL ENROLLMENT IN THE DENTAL SCHOOLS OF THE UNITED STATES AS OF OCTOBER 15, 1942

SCHOOL OR COLLEGE	UNDERGRADUATES							OTHER STUDENTS							ALL STUDENTS		
	Freshmen	Sophomores	Juniors	Seniors	Men	Women	Total	Specials	Graduate	Post Grad.	Dental Hygienists	Men	Women	Total	Men	Women	Total
California																	
College of Physicians & Surgeons	48	43	37	36	161	3	164	2	–	–	–	2	–	2	163	3	166
University of California	54	32	47	35	165	3	168	–	–	–	11	–	11	11	165	14	179
University of Southern California	101	110	94	78	379	4	383	–	4	–	6	4	6	10	383	10	393
District of Columbia																	
Georgetown University	49	58	46	44	197	–	197	–	–	–	–	–	–	–	197	–	197
Howard University	52	26	25	18	119	2	121	–	–	–	5	–	5	5	119	7	126
Georgia																	
Atlanta-Southern Dental College	84	97	102	76	354	5	359	–	–	–	–	–	–	–	354	5	359
Illinois																	
Loyola University, Chicago	92	57	86	70	305	–	305	1	5	–	–	6	–	6	311	–	311
Northwestern University	113	70	60	74	315	2	317	–	17	13	19	30	19	49	345	21	366
University of Illinois	67	53	54	54	226	2	228	–	11	1	–	12	–	12	238	2	240
Indiana																	
Indiana University	48	37	42	25	151	1	152	–	1	–	–	1	–	1	152	1	153
Iowa																	
State University of Iowa	53	30	32	40	154	1	155	–	1	–	–	1	–	1	155	1	156
Kentucky																	
University of Louisville	53	50	40	53	193	3	196	–	–	–	–	–	–	–	193	3	196
Louisiana																	
Loyola University, New Orleans	43	34	32	36	145	–	145	–	–	–	–	–	–	–	145	–	145
Maryland																	
University of Maryland	76	87	78	84	324	1	325	–	–	–		–	–	–	324	1	325
Massachusetts																	
*Harvard University	9	6	38	36	89	–	89	–	–	1	–	1	–	1	90	–	90
Tufts College	82	82	76	68	305	3	308	–	–	–	–	–	–	–	305	3	308
Michigan																	
University of Detroit	36	13	23	24	96	–	96	–	–	–	–	–	–	–	96	–	96
University of Michigan	80	51	38	44	210	3	213	1	14	46	32	61	32	93	271	35	306
Minnesota																	
University of Minnesota	103	79	56	62	298	2	300	–	10	2	60	12	60	72	310	62	372
Missouri																	
University of Kansas City	103	55	78	61	297	–	297	–	–	–	–	–	–	–	297	–	297
St. Louis University	56	74	60	39	229	–	229	–	–	–	–	–	–	–	229	–	229
Washington University	47	35	16	23	117	4	121	–	–	–	–	–	–	–	117	4	121
Nebraska																	
Creighton University	33	24	20	25	99	3	102	–	–	–	–	–	–	–	99	3	102
University of Nebraska	32	27	14	15	88	–	88	–	–	–	–	–	–	–	88	–	88
New York																	
Columbia University	49	50	50	53	200	2	202	–	–	12	25	11	26	37	211	28	239
New York University	140	145	141	135	559	2	561	–	–	25	–	24	1	25	583	3	586
University of Buffalo	61	0	48	40	149	–	149	–	–	–	–	–	–	–	149	–	149
Ohio																	
Ohio State University	83	59	55	64	260	1	261	–	–	–	–	–	–	–	260	1	261
Western Reserve University	53	48	34	43	177	1	178	–	–	–	–	–	–	–	177	1	178
Oregon																	
North Pacific College of Oregon	128	70	51	54	302	1	303	13	–	2	8	15	8	23	317	9	326
Pennsylvania																	
Temple University	114	116	107	92	422	7	429	–	–	–	10	–	10	10	422	17	439
University of Pennsylvania	127	107	97	88	416	3	419	3	–	–	32	2	33	35	418	36	454
University of Pittsburgh	96	89	83	74	335	7	342	–	–	1	–	1	–	1	336	7	343
Tennessee																	
Meharry Medical College	30	17	9	8	62	2	64	–	–	1	–	–	1	1	62	3	65
University of Tennessee	28	22	27	26	102	1	103	–	–	1	5	1	5	6	103	6	109
Texas																	
Baylor University	63	51	37	39	190	–	190	1	–	–	–	1	–	1	191	–	191
Texas Dental College	54	34	31	24	142	1	143	–	–	–	–	–	–	–	142	1	143
Virginia																	
Medical College of Virginia	50	48	25	26	149	–	149	–	–	–	–	–	–	–	149	–	149
Wisconsin																	
Marquette University	112	72	52	60	293	3	296	–	–	–	27	–	27	27	293	30	323
TOTALS - 1942	2702	2158	2041	1946	8774	73	8847	21	63	105	240	185	244	429	8959	317	9276

*Freshmen and Sophomores in Harvard School of Dental Medicine.

*Does not include post graduate students enrolled at other times in academic year

TABLE 2.—RECAPITULATION OF UNDERGRADUATE ENROLLMENT IN THE DENTAL SCHOOLS OF THE UNITED STATES, 1933-1942 INCLUSIVE

SCHOOL OR COLLEGE	1933-1934	1934-1935	1935-1936	1936-1937	1937-1938	1938-1939	1939-1940	1940-1941	1941-1942	1942-1943
California										
College of Physicians & Surgeons	136	142	136	141	135	151	147	151	163	164
University of California	128	140	142	159	152	179	163	168	181	168
University of Southern California	282	286	298	348	327	297	309	338	385	383
District of Columbia										
Georgetown University	208	193	165	124	155	166	165	183	201	197
Howard University	38	35	38	37	40	45	58	72	89	121
Georgia										
Atlanta-Southern Dental College	294	284	301	326	299	313	318	319	351	359
Illinois										
Loyola University, Chicago	321	293	272	305	269	264	259	269	274	305
Northwestern University	347	322	341	325	326	302	286	295	295	317
University of Illinois	97	125	146	162	196	220	222	224	229	228
Indiana										
Indiana University	152	166	163	188	152	137	118	113	130	152
Iowa										
State University of Iowa	141	145	167	186	145	118	127	112	133	155
Kentucky										
University of Louisville	121	111	122	107	104	139	163	177	186	196
Louisiana										
Loyola University, New Orleans	147	133	134	165	166	177	167	154	156	145
Maryland										
University of Maryland	324	352	294	219	222	216	255	310	322	325
Massachusetts										
Harvard University	122	127	151	145	152	154	154	146	119	89*
Tufts College	283	258	257	240	240	249	245	257	282	308
Michigan										
University of Detroit	86	127	101	95	100	114	112	106	91	96
University of Michigan	146	151	161	150	135	153	162	158	186	213
Minnesota										
University of Minnesota	214	275	293	302	283	242	208	197	264	300
Missouri										
University of Kansas City	222	231	238	241	203	207	204	240	259	297
St. Louis University	159	154	178	200	188	170	150	167	236	229
Washington University	161	139	131	122	116	120	123	90	107	121
Nebraska										
Creighton University	96	92	96	77	76	71	75	76	76	102
University of Nebraska	72	66	73	76	67	62	55	48	73	88
New York										
Columbia University	178	183	179	196	201	198	203	215	206	202
New York University	504	516	518	532	540	535	533	551	561	561
University of Buffalo	137	131	123	117	130	140	141	142	135	149
Ohio										
Ohio State University	198	198	207	202	193	202	209	222	235	261
Western Reserve University	107	116	121	124	132	140	162	161	172	178
Oregon										
North Pacific College of Oregon	178	153	157	191	158	167	182	171	220	303
Pennsylvania										
Temple University	500	510	507	457	430	437	405	439	460	429
University of Pennsylvania	326	324	341	382	401	417	414	425	413	419
University of Pittsburgh	186	184	187	163	127	159	220	297	334	342
Tennessee										
Meharry Medical College	20	22	25	21	33	34	33	41	51	64
University of Tennessee	113	93	87	113	108	111	109	105	110	109
Texas										
Baylor University	102	107	110	125	128	134	151	144	173	190
Texas Dental College	47	59	65	79	80	81	81	87	112	143
Virginia										
Medical College of Virginia	99	90	110	112	124	136	137	135	139	149
Wisconsin										
Marquette University	168	142	171	145	154	175	192	215	248	296
ANNUAL TOTALS	7160	7175	7306	7397	7184	7331	7407	7720	8355	8847
ANNUAL AVERAGE PER SCHOOL	184	184	187	189	184	188	190	198	214	227

*Includes 15 in Harvard School of Dental Medicine

TABLE 3.—PRE-DENTAL COLLEGE TRAINING OF UNDERGRADUATES IN REGULAR COURSE IN THE DENTAL SCHOOLS OF THE UNITED STATES AS OF OCTOBER 15, 1942

SCHOOL OR COLLEGE	ALL UNDERGRADUATES							FRESHMEN					
	Less Than 2 Years	2 Years	3 Years	4 Years Without Degree	Bachelor's Degree	Beyond Bachelor's Degree	Total	2 Years	3 Years	4 Years Without Degree	Bachelor's Degree	Beyond Bachelor's Degree	Total
California													
College of Physicians & Surgeons	-	101	38	3	18	4	164	31	9	-	8	-	48
University of California	-	106	25	8	28	1	168	30	6	4	13	1	54
University of Southern California	-	281	32	10	54	6	383	74	6	6	14	1	101
District of Columbia													
Georgetown University	-	87	37	12	61	-	197	22	6	3	18	-	49
Howard University	-	27	23	4	67	-	121	7	13	3	29	-	52
Georgia													
Atlanta-Southern Dental College	-	228	56	9	66	-	359	53	13	3	15	-	84
Illinois													
Loyola University, Chicago	2	203	44	4	50	2	305	42	27	2	20	1	92
Northwestern University	-	129	87	21	75	5	317	37	48	6	20	2	113
University of Illinois	-	118	65	3	41	1	228	29	22	2	13	1	67
Indiana													
Indiana University	-	71	43	14	24	-	152	21	13	4	10	-	48
Iowa													
State University of Iowa	-	84	39	5	25	2	155	26	18	2	7	-	53
Kentucky													
University of Louisville	-	73	51	19	51	2	196	20	13	4	16	-	53
Louisiana													
Loyola University, New Orleans	-	88	24	7	26	-	145	20	10	5	8	-	43
Maryland													
University of Maryland	-	190	47	8	80	-	325	28	24	4	20	-	76
Massachusetts													
*Harvard University	-	32	18	-	38	1	89	-	7	-	2	-	9
Tufts College	-	155	57	6	84	6	308	39	24	-	18	1	82
Michigan													
University of Detroit	-	62	12	3	18	1	96	20	6	1	9	-	36
University of Michigan	-	99	52	6	51	5	213	42	24	3	11	-	80
Minnesota													
University of Minnesota	-	177	84	12	21	6	300	55	39	3	6	-	103
Missouri													
University of Kansas City	-	206	32	10	48	1	297	57	17	5	22	2	103
St. Louis University	-	111	38	21	51	8	229	16	16	6	17	1	56
Washington University	-	56	20	6	37	2	121	20	9	1	16	1	47
Nebraska													
Creighton University	1	69	19	4	8	1	102	19	10	2	2	-	33
University of Nebraska	-	59	20	2	7	-	88	18	12	-	2	-	32
New York													
Columbia University	-	-	41	2	154	5	202	-	14	-	33	2	49
New York University	-	37	163	18	336	7	561	7	67	8	57	1	140
University of Buffalo	-	68	42	4	33	2	149	25	22	3	11	-	61
Ohio													
Ohio State University	-	134	56	13	55	3	261	54	13	2	12	2	83
Western Reserve University	-	61	54	16	47	-	178	17	13	4	19	-	53
Oregon													
North Pacific College of Oregon	-	159	56	17	61	10	303	68	23	10	25	2	128
Pennsylvania													
Temple University	-	264	63	16	85	1	429	84	16	3	11	-	114
University of Pennsylvania	-	176	76	5	155	7	419	54	30	-	43	-	127
University of Pittsburgh	-	181	59	8	88	6	342	58	14	1	23	-	96
Tennessee													
Meharry Medical College	-	11	9	1	43	-	64	4	7	-	19	-	30
University of Tennessee	-	44	22	11	25	1	103	10	5	7	6	-	28
Texas													
Baylor University	-	107	29	22	30	2	190	33	13	3	13	1	63
Texas Dental College	-	77	19	8	36	3	143	24	9	4	17	-	54
Virginia													
Medical College of Virginia	-	37	41	18	53	-	149	7	14	7	22	-	50
Wisconsin													
Marquette University	-	170	47	10	68	1	296	65	23	6	18	-	112
TOTALS	3	4338	1740	366	2298	102	8847	1236	675	127	645	19	2702

*Includes 18 in Harvard School of Dental Medicine

TABLE 4.—PRE-DENTAL COLLEGE TRAINING OF GRADUATES OF THE DENTAL SCHOOLS IN THE UNITED STATES FOR YEAR ENDING JUNE 30, 1942

SCHOOL OR COLLEGE	Less Than 2 Years	2 Years	3 Years	4 Years Without Degree	Bachelor's Degree	Other Degree	Total	Per Cent Entering With Degree	No. Graduating Women
California									
College of Physicians & Surgeons	1	19	9	3	1	0	33	3	7
University of California	2	19	3	2	4	0	30	13	28
University of Southern California	0	18	12	7	8	1	46	20	20
District of Columbia									
Georgetown University	0	18	11	2	13	0	44	30	0
Howard University	0	0	3	0	13	1	17	82	0
Georgia									
Atlanta-Southern Dental College	0	39	8	2	21	0	70	30	0
Illinois									
Loyola University, Chicago	1	37	8	3	5	1	55	11	0
Northwestern University	0	39	32	3	11	5	90	18	0
University of Illinois	0	31	9	1	12	1	54	24	40
Indiana									
Indiana University	0	13	1	0	5	0	19	26	0
Iowa									
State University of Iowa	1	10	2	0	3	0	16	19	4
Kentucky									
University of Louisville	0	20	4	3	10	0	37	27	0
Louisiana									
Loyola University, New Orleans	0	26	5	3	9	0	43	21	0
Maryland									
University of Maryland	0	41	5	1	15	0	62	24	0
Massachusetts									
Harvard University	2	16	4	0	13	3	38	42	0
Tufts College	0	17	15	2	20	2	56	40	0
Michigan									
University of Detroit	0	24	3	0	5	0	32	16	0
University of Michigan	0	11	7	0	10	1	29	38	2
Minnesota									
University of Minnesota	0	31	11	3	5	2	52	13	0
Missouri									
University of Kansas City	1	31	8	0	10	0	50	20	1
St. Louis University	0	32	13	1	11	1	58	21	0
Washington University	1	18	1	3	3	0	26	12	4
Nebraska									
Creighton University	0	7	3	0	2	0	12	17	0
University of Nebraska	1	4	3	1	3	0	12	25	8
New York									
Columbia University	0	0	10	0	36	3	49	80	3
New York University	0	6	49	8	62	2	127	50	20
University of Buffalo	0	21	4	1	18	0	44	41	0
Ohio									
Ohio State University	0	15	16	1	13	0	45	29	0
Western Reserve University	0	17	4	0	12	0	33	36	12
Oregon									
North Pacific College of Oregon	0	15	4	3	7	1	30	27	7
Pennsylvania									
Temple University	0	83	26	5	17	0	131	13	0
University of Pennsylvania	0	29	16	2	43	4	94	50	0
University of Pittsburgh	1	36	10	0	15	12	74	36	9
Tennessee									
Meharry Medical College	0	2	3	1	5	0	11	45	0
University of Tennessee	2	8	4	5	8	0	27	30	0
Texas									
Baylor University	0	15	9	6	4	0	34	12	1
Texas Dental College	0	12	0	0	6	0	18	33	0
Virginia									
Medical College of Virginia	0	15	8	0	8	0	31	26	0
Wisconsin									
Marquette University	0	31	7	2	15	0	55	27	8
TOTALS	13	826	350	74	481	40	1784	29	174

TABLE 5.—GRADUATES WITH PRE-DENTAL COLLEGE TRAINING OF BACHELOR'S DEGREE OR BEYOND IN THE DENTAL SCHOOLS OF THE UNITED STATES, 1936 TO 1942 INCLUSIVE

SCHOOL OR COLLEGE	1936		1937		1938		1939		1940		1941		1942		
	Total No.	No. With Degree	Total No.	No. With Degree	Total No.	No. With Degree	Total No.	No. With Degree	Total No.	No. With Degree	Total No.	No. With Degree	Total No.	No. With Degree	Per Cent With Degree
California															
College of Physicians & Surgeons	22	8	33	18	36	10	18	3	36	9	27	4	33	1	3
University of California	32	11	32	12	30	21	37	17	38	4	27	11	30	4	13
University of Southern California	59	12	54	10	72	20	65	16	71	10	75	6	46	9	20
District of Columbia															
Georgetown University	73	7	18	2	29	9	45	12	25	9	41	20	44	13	30
Howard University	6	2	11	1	7	1	7	4	7	4	10	7	17	14	82
Georgia															
Atlanta-Southern Dental College	75	5	64	5	64	3	69	11	110	14	52	16	70	21	30
Illinois															
Loyola University, Chicago	71	4	60	–	64	–	75	7	80	5	43	4	55	6	11
Northwestern University	91	23	85	20	99	30	108	13	75	27	80	21	90	16	18
University of Illinois	22	18	21	19	29	25	37	31	58	12	48	9	54	13	24
Indiana															
Indiana University	28	3	45	4	43	5	46	2	44	1	18	3	19	5	26
Iowa															
State University of Iowa	22	3	44	1	46	2	45	1	38	–	16	3	16	3	19
Kentucky															
University of Louisville	35	5	40	8	8	1	27	8	28	10	41	16	37	10	27
Louisiana															
Loyola University, New Orleans	29	2	36	1	38	2	35	6	46	3	27	4	43	9	21
Maryland															
University of Maryland	79	1	73	3	66	4	63	4	15	5	74	20	62	15	24
Massachusetts															
Harvard University	39	17	24	11	33	13	29	10	39	21	33	16	38	16	42
Tufts College	66	8	64	13	51	17	64	24	57	28	63	23	56	22	39
Michigan															
University of Detroit	35	8	37	11	14	3	16	–	23	2	29	7	32	5	16
University of Michigan	46	12	49	8	24	5	33	7	35	9	34	10	29	11	38
Minnesota															
University of Minnesota	75	14	87	–	92	9	100	13	75	7	13	4	52	7	13
Missouri															
University of Kansas City	50	3	44	10	60	9	67	8	44	2	25	7	50	10	20
St. Louis University	38	1	38	5	63	12	53	6	32	1	25	8	58	12	21
Washington University	45	3	25	1	31	3	20	1	37	6	25	4	26	3	12
Nebraska															
Creighton University	20	1	28	–	18	–	24	4	13	2	18	3	12	2	17
University of Nebraska	17	3	11	–	19	2	18	4	18	5	10	2	12	3	25
New York															
Columbia University	34	28	45	35	46	44	51	47	44	29	53	30	49	39	80
New York University	128	25	117	37	121	34	128	57	121	64	119	88	127	64	50
University of Buffalo	39	7	35	13	29	9	34	17	50	28	43	15	44	18	41
Ohio															
Ohio State University	45	3	58	6	40	3	55	–	42	7	41	9	45	13	29
Western Reserve University	25	10	23	13	28	13	28	17	35	17	44	14	33	12	36
Oregon															
North Pacific College of Oregon	35	4	36	5	35	4	39	–	62	7	25	10	30	8	27
Pennsylvania															
Temple University	110	6	127	–	120	3	114	3	84	8	95	16	131	17	13
University of Pennsylvania	75	9	79	19	72	19	98	27	90	40	115	46	94	47	50
University of Pittsburgh	48	18	70	34	40	21	20	6	33	10	46	20	74	27	36
Tennessee															
Meharry Medical College	6	5	4	3	5	1	5	1	5	3	9	7	11	5	45
University of Tennessee	21	1	20	2	21	3	20	–	35	11	15	1	27	8	30
Texas															
Baylor University	23	2	26	4	32	1	27	3	35	5	25	3	34	4	12
Texas Dental College	10	–	11	1	19	1	17	–	31	3	11	3	18	6	33
Virginia															
Medical College of Virginia	23	3	22	1	16	2	31	6	23	5	34	9	31	8	26
Wisconsin															
Marquette University	39	14	43	16	44	19	25	6	23	12	39	8	55	15	27
TOTALS	1736	309	1739	352	1704	383	1794	402	1757	445	1568	507	1784	521	29
Per Cent with Degree		18		20		22		22		25		32		29	

TABLE 6.—DISTRIBUTION OF UNDERGRADUATE STUDENTS BY STATES, TERRITORIES AND FOREIGN COUNTRIES IN THE DENTAL SCHOOLS OF THE UNITED STATES AS OF OCTOBER 15, 1942

	Alabama	Arizona	Arkansas	California	Colorado	Connecticut	Delaware	District of Columbia	Florida	Georgia	Idaho	Illinois	Indiana	Iowa	Kansas	Kentucky	Louisiana	Maine	Maryland	Massachusetts	Michigan	Minnesota
California																						
College of Physicians & Surgeons				131	2						1			1					1			
University of California				143	1	1					2	1										
University of Southern California		19		221	15	2					11	5	2	5	1					1	2	
District of Columbia																						
Georgetown University		1				20		42	2			1				1		5	6	14		
Howard University	7		2			1	1	4	9	4		2					1	3	4	2		
Georgia																						
Atlanta-Southern Dental College	52			3		3	1	2	74	48		1	3			1	1	2		8	3	1
Illinois																						
Loyola University, Chicago						8			3			218	8						1	4	21	1
Northwestern University	2	1		1	5	4		2	10	3	3	137	9	1		1	3	1		7	16	3
University of Illinois						1						156		1	1							
Indiana																						
Indiana University						11			1				115			1				3	2	
Iowa																						
State University of Iowa					1						1	4		127				3		1		
Kentucky																						
University of Louisville	3		2						6	1			6			89		2	1	3		
Louisiana																						
Loyola University, New Orleans	9		2	1		2			10								88				1	
Maryland																						
University of Maryland	1					35	4	5	3									3	60	18		
Massachusetts																						
*Harvard University				1		8		1				1						4		44		1
Tufts College						37												14		172		
Michigan																						
University of Detroit											1					1					91	
University of Michigan	1				1				1	1		4	1							1	171	
Minnesota																						
University of Minnesota				3					1				1	1						1		215
Missouri																						
University of Kansas City	1	4	5	2	23	1			1		4	1	1	4	74		1			1	2	1
St. Louis University	4	1	4		1	9			3			29	4	6		3		1		5		
Washington University	1		10	5	1						4	17	1		2					2		1
Nebraska																						
Creighton University					4						1	2		20	2							4
University of Nebraska				3	7							1	1	5	1					2		
New York																						
Columbia University						5												3		2		
New York University																				2		
University of Buffalo				1		1														2		
Ohio																						
Ohio State University						1										1					1	
Western Reserve University		1			1	1		1	1											1	5	
Oregon																						
North Pacific College of Oregon		1		13	1						16									1		
Pennsylvania																						
Temple University						15	11		1										2	13		
University of Pennsylvania						16	3											2	1	7		
University of Pittsburgh						2		1												5	1	
Tennessee																						
McHarry Medical College	4		3		1				2			3				2	4		4		5	
University of Tennessee	6		6								1					2	1			2		
Texas																						
Baylor University	1		9						1		1						2			1	1	
Texas Dental College		1	2	1								1				2	8					
Virginia																						
Medical College of Virginia		1				1	1		2										1			
Wisconsin																						
Marquette University						2						5		2							15	5
TOTALS	92	30	45	529	64	187	21	58	131	57	46	589	152	173	83	104	112	39	89	320	338	231

*Includes 16 in Harvard School of Dental Medicine

TABLE 6.—DISTRIBUTION OF UNDERGRADUATE STUDENTS BY STATES, TERRITORIES AND FOREIGN COUNTRIES IN THE DENTAL SCHOOLS OF THE UNITED STATES AS OF OCTOBER 15, 1942 (CONT.)

Minnesota	Missouri	Montana	Nebraska	Nevada	New Hampshire	New Jersey	New Mexico	New York	North Carolina	North Dakota	Ohio	Oklahoma	Oregon	Pennsylvania	Rhode Island	South Carolina	South Dakota	Tennessee	Texas	Utah	Vermont	Virginia	Washington	West Virginia	Wisconsin	Wyoming	U.S. Possessions	Canada	Other Foreign Countries	Total
2				2				2					4						1	6			4				1	2	6	164
3				1				1					1				1		6				3					2	1	168
1	2	3	1			2	4	6		1	3		1	1			1			46	3		6		3	1	6	2	6	383
					3	18	1	56			1			5	5			2	6	1	1	8		1			4		1	197
3						5		12	8		1	1		5		8						7		2	1		5	1	14	121
13			1			4		2	74		4			2		32		4	4			2		10	2		2			359
	1				1	2		9		1	9			1						1				1	13			2		305
3	1	5			1		1	1	4	4	8	3	1	8	1	2	3	1	6	10		2	6	14	12		6	1	4	317
1						12		48						9			1										1		3	228
						5		2			7							1						1			3			152
	1	1				2		3		3		1		2			1								1	1	1		1	155
1	1							18	5		8				1	3		23	1			1		18	1		2			196
6	1							1	1		1	2						2	9								6		3	145
					4	50		84	9					5	8	4					2	4		16			9		1	325
					4	3		9		1				4	7						1									89
					15	5		39							21						4	1								308
								1			1			1																96
					1	2		13			6							1		1		1	1	1			1		4	213
		6				2		9		27							6							1	20	2	2	1	2	300
1	70		2			1	3	6		8		50		2					9	6			3			2	7			297
	51	2				18		64		5			1	1	7			1	4	1				2			2			229
1	24	1				3		14				9		1	2		1	1	9	1	1		1	1	1		4		2	121
	1	8	28					2		1							12		2	1	1		1		3	6	2		1	102
			55			2		1		1		2					1		1	1			2			2				88
						14		176								1								1						202
						27		531						1																561
						4		139																1				1		149
						3		29			222								1					3						261
						6		53			102			3										2	1					178
		8		1				1					122				1			14			93			1	5	25		303
					1	96		107						176	5							1					1			429
1						89		194	2		1			87	5				1		1	2			1		2		4	419
						22		136			10			148										16	1					342
2						6		2			2	1		2	1	1		7	5			2					2		3	64
20		1						1	2			1				1		57				1		1						103
1							3					26					1	1	143								1			190
								1				3						1	120					1					1	143
						4		19	40		1			1		8			1			63		6						189
		5				5		59		2	2			3				1						1	187		2			296
54	153	40	87	4	30	412	12	1851	145	55	389	99	130	462	64	59	29	102	329	89	14	95	120	100	247	15	77	37	57	8847

TABLE 7.—SCHOOLS OF DENTAL HYGIENE

Title of School or Course	Institution with Which Connected	Admission Requirement	Length of Course	Enrollment 10/15/42	Graduates Year Ending 6/30/43	Degree or Certificate
Curriculum for the Training of Dental Hygienists	College of Dentistry University of California San Francisco	2 Years in Liberal Arts	2 Years	11	5	B.S. in Dental Hygiene
Division of Dental Hygiene	College of Dentistry University of Southern California, Los Angeles	2 Years in Liberal Arts	2 Years	6	3	B.S. in Dental Hygiene
Course for Dental Hygienists	College of Dentistry Howard University Washington, D.C.	High School Course	1 Year	5	2	Certificate
Course for Dental Hygienists and Dental Assistants	Dental School Northwestern University Chicago, Illinois	High School Course	2 Years	19	8	Certificate
Curriculum in Dental Hygiene	School of Dentistry University of Michigan Ann Arbor	High School Course	2 Years	32	15	Certificate
Course for Dental Hygienists	School of Dentistry University of Minnesota Minneapolis	High School Course	2 Years	60	51	Graduate Dental Hygienist (GDH)
Courses for Dental Hygienists	School of Dental and Oral Surgery, Columbia University New York City	High School Course	1 Year	25	38	Certificate
Courses for Dental Assistants and Dental Hygienists	School of Dentistry North Pacific College of Oregon, Portland	High School Course	1 Year 2 Years	8	3	Certificate
School of Oral Hygiene	School of Dentistry Temple University Philadelphia	High School Course or 3 Years in Teachers' College	1 Year 1 Year	10	23	Certificate B.S. in Education with Certificate in Oral Hygiene
Courses in Oral Hygiene	School of Dentistry University of Pennsylvania Philadelphia	High School Course	1 Year	82	36	Certificate
School of Dental Hygiene	College of Dentistry University of Tennessee Memphis	High School Course	2 Years	5	3	Certificate
Curriculum for Dental Hygienists	Dental School Marquette University Milwaukee, Wisconsin	High School Course	2 Years	27	13	Certificate
Forsyth Training School for Dental Hygienists	Forsyth Dental Infirmary Boston, Massachusetts	High School Course	Eleven Months	52	52	Certificate
School for Dental Hygienists	Eastman Dental Dispensary Rochester, New York	High School Course	1 Year	35	64	Certificate
Department of Oral Hygiene	West Liberty State Teachers' College West Liberty, W. Va.	High School Course	2 Years 2 Additional Years	14	4	Certificate B.S. in Oral Hygiene
School for Dental Hygienists	The Murry and Leonie Guggenheim Dental Clinic New York City	High School Course	1 Year	46	41	Certificate
TOTAL				387	361	

TABLE 8.—ADMINISTRATIVE OFFICERS OF THE DENTAL SCHOOLS OF THE UNITED STATES

SCHOOL OR COLLEGE	LOCATION	DEAN
California		
College of Physicians & Surgeons	San Francisco, California	Ernest O. Sloman
University of California	San Francisco, California	Willard C. Fleming
University of Southern California	Los Angeles, California	Lewis E. Ford
District of Columbia		
Georgetown University	Washington, D.C.	Joseph L. B. Murray
Howard University	Washington, D.C.	Russell A. Dixon
Georgia		
Atlanta-Southern Dental College	Atlanta, Georgia	Ralph R. Byrnes
Illinois		
Loyola University, Chicago	Chicago, Illinois	William H. G. Logan
Northwestern University	Chicago, Illinois	Charles W. Freeman
University of Illinois	Chicago, Illinois	Howard M. Marjerison
Indiana		
Indiana University	Indianapolis, Indiana	William H. Crawford
Iowa		
State University of Iowa	Iowa City, Iowa	Alvin W. Bryan
Kentucky		
University of Louisville	Louisville, Kentucky	John T. O'Rourke
Louisiana		
Loyola University, New Orleans	New Orleans, Louisiana	Sydney L. Tiblier
Maryland		
University of Maryland	Baltimore, Maryland	J. Ben Robinson
Massachusetts		
Harvard University	Boston, Massachusetts	Leroy M. S. Miner
Tufts College	Boston, Massachusetts	Basil G. Bibby
Michigan		
University of Detroit	Detroit, Michigan	Leo A. Cadarette
University of Michigan	Ann Arbor, Michigan	Russell W. Bunting
Minnesota		
University of Minnesota	Minneapolis, Minnesota	William F. Lasby
Missouri		
University of Kansas City	Kansas City, Missouri	Roy J. Rinehart
St. Louis University	St. Louis, Missouri	Thomas E. Purcell
Washington University	St. Louis, Missouri	Benno E. Lischer
Nebraska		
Creighton University	Omaha, Nebraska	Frank J. Viner
University of Nebraska	Lincoln, Nebraska	Bert L. Hooper
New York		
Columbia University	New York City	Willard Cole Rappleye H. Holliday, Associate
New York University	New York City	Allen T. Newman
University of Buffalo	Buffalo, New York	Edward W. Koch R. W. Groh, Associate
Ohio		
Ohio State University	Columbus, Ohio	Wendell D. Postle
Western Reserve University	Cleveland, Ohio	William L. Wylie
Oregon		
North Pacific College of Oregon	Portland, Oregon	Herbert C. Miller, President and Acting Dean
Pennsylvania		
Temple University	Philadelphia, Pennsylvania	Gerald D. Timmons
University of Pennsylvania	Philadelphia, Pennsylvania	J. L. T. Appleton
University of Pittsburgh	Pittsburgh, Pennsylvania	H. Edmund Friesell
Tennessee		
Meharry Medical College	Nashville, Tennessee	M. Don Clawson
University of Tennessee	Memphis, Tennessee	R. D. Dean
Texas		
Baylor University	Dallas, Texas	Frederick W. Hinds
Texas Dental College	Houston, Texas	Frederick C. Elliott
Virginia		
Medical College of Virginia	Richmond, Virginia	Harry Bear
Wisconsin		
Marquette University	Milwaukee, Wisconsin	Henry L. Banzhaf

TABLE 9.—ACCELERATED SCHEDULES IN DENTAL SCHOOLS IN THE UNITED STATES REVISED TO DECEMBER 15, 1942

SCHOOL OR COLLEGE	Present Classes Graduate				Next New Class	
	Seniors	Juniors	Sophomores	Freshmen	Enters	Graduates
California						
College of Physicians & Surgeons	Apr., 1943	Jan., 1944	Oct., 1944	July, 1945	July, 1943	July, 1946
University of California	Feb , 1943	Oct., 1943	June, 1944	Feb., 1945	Feb., 1943	Oct., 1945
University of Southern California	Mar., 1943	Nov., 1943	July, 1944	Not Fixed	Mar., 1943	Not Fixed
District of Columbia						
Georgetown University	Mar., 1943	Dec., 1943	Sep., 1944	June, 1945	Mar., 1943	Mar., 1946
Howard University	June, 1943	Mar., 1944	Dec., 1944	Sep., 1945	June, 1943	June, 1946
Georgia						
Atlanta-Southern Dental College	Feb., 1943	Nov., 1943	Aug., 1944	May, 1945	Mar., 1943	June, 1946
Illinois						
Loyola University, Chicago	June, 1943	Mar., or June, 1944	Dec., 1944	Sep., 1945	June, 1943	June, 1946
Northwestern University	Mar., June Sep., 1943	Dec., 1943	June and Sep., 1944	June and Sep., 1945	June, 1943	June, 1946
University of Illinois	June, 1943	Mar., 1944	Dec., 1944	Sep., 1945	June, 1943	June, 1946
Indiana						
Indiana University	Jan., 1943	Sep., 1943	May, 1944	Jan., 1945	Jan., 1943	Sep., 1945
Iowa						
State University of Iowa	Dec., 1942	Aug., 1943	Apr., 1944	Apr., 1945	Sep., 1943	Apr., 1946
Kentucky						
University of Louisville	Feb., 1943	Nov., 1943	Aug., 1944	May, 1945	Apr., 1943	Feb., 1946
Louisiana						
Loyola University, New Orleans	Feb., 1943	Oct., 1943	May, 1944	Feb., 1945	Jan., 1943	Oct., 1945
Maryland						
University of Maryland	Mar., 1943	Nov., 1943	July, 1944	Mar., 1945	Mar., 1943	Nov., 1945
Massachusetts						
Harvard University	June, 1943	June, 1944	-	-	-	-
Tufts College	Feb., 1943	Nov., 1943	Aug., 1944	May, 1945	Apr., 1943	Feb., 1946
Michigan						
University of Detroit	Feb., 1943	Sep., 1943	June, 1944	June, 1945	Sep., 1943	June, 1946
University of Michigan	Jan., 1943	Jan., 1944	May, 1944	May, 1945	Oct., 1943	May, 1946
Minnesota						
University of Minnesota	Mar., 1943	Dec., 1943	Aug., 1944	Aug., 1945	June, 1943	June, 1946
Missouri						
University of Kansas City	Jan., 1943	Sep., 1943	June, 1944	June, 1945	Sep., 1943	June, 1946
St. Louis University	Feb., 1943	Oct., 1943	Jan., 1944	Feb., 1945	Feb., 1943	Oct., 1945
Washington University	Mar., 1943	Dec., 1943	Aug., 1944	Aug., 1945	July, 1943	June, 1946
Nebraska						
Creighton University	Mar., 1943	Nov., 1943	July, 1944	Mar., 1945	Mar., 1943	Jan., 1946
University of Nebraska	May, 1943	Jan., 1944	Aug., 1944	Aug., 1945	Sept, 1943	Aug., 1946
New York						
Columbia University	Mar., 1943	Dec., 1943	Sep., 1944	June, 1945	Mar., 1943	Mar., 1946
New York University	Mar., 1943	Dec., 1943	Sep., 1944	June, 1945	Mar., 1943	Mar., 1946
University of Buffalo	June, 1943		June, 1944	June, 1945	July, 1943	June, 1946
Ohio						
Ohio State University	Mar., 1943	Dec., 1943	Sep., 1944	June, 1945	Mar., 1943	Mar., 1946
Western Reserve University	Feb., 1943	Oct., 1943	July, 1944	Apr., 1945	Mar., 1943	Jan., 1946
Oregon						
North Pacific College of Oregon	Feb., 1943	Sep., 1943 Feb., 1944	June, 1944	June, 1945	June, 1943	- 1946
Pennsylvania						
Temple University	Feb., 1943	Oct., 1943	June, 1944	Feb., 1945	Feb., 1943	Oct., 1945
University of Pennsylvania	Apr., 1943	Dec., 1943	Oct., 1944	May, 1945	Apr., 1943	Apr., 1946
University of Pittsburgh	Feb., 1943	Oct., 1943	June, 1944	Feb., 1945	Feb., 1943	Oct., 1945
Tennessee						
Meharry Medical College	June, 1943	Feb., 1944	Nov., 1944	Aug., 1945	June, 1943	May, 1946
University of Tennessee	Mar., 1943	Dec., 1943	Sep., 1944	June, 1945	Jan., 1943	Dec., 1945
Texas						
Baylor University	May, 1943	Mar., 1944	Dec., 1944	Sep., 1945	June, 1943	June, 1946
Texas Dental College	Mar., 1943	Jan., 1944	Sep., 1944	Sep., 1945	June, 1943	June, 1946
Virginia						
Medical College of Virginia	Mar., 1943	Dec., 1943	Sep., 1944	July, 1945	Apr., 1943	Apr., 1946
Wisconsin						
Marquette University	Feb., 1943	Oct., 1943	June, 1944	June, 1945	June, 1943	Feb., 1946

TABLE 10.—PERCENTAGES OF FAILURES IN LICENSING EXAMINATIONS, 1939, 1940, 1941

BOARDS					INSTITUTIONS				
STATES	1939	1940	1941	Average for 3 Years	SCHOOL OR COLLEGE	1939	1940	1941	Average for 3 Years
Alabama	16	10	22	16.	College of Physicians & Surgeons	9	3	7	6.3
Arizona	70	60	40	56.6	University of California	11	0	0	3.6
Arkansas	20	12	25	19.	University of Southern California	10	8	2	6.6
California	21	18	12	17.	Georgetown University	37	35	25	32.3
Colorado	24	10	8	14.	Howard University	34	33	20	29.
Connecticut	13	16	18	15.6	Atlanta-Southern Dental College	27	20	13	20.
Delaware	69	55	25	49.6	Loyola, Chicago	13	14	18	15.
District of Columbia	56	55	50	53.6	Northwestern University	20	23	17	20.
Florida	44	49	35	42.6	University of Illinois	23	13	11	15.6
Georgia	24	18	0	14.	Indiana University	13	12	18	14.3
Idaho	50	29	40	39.6	State University of Iowa	15	11	11	12.3
Illinois	7	5	9	7.	University of Louisville	28	20	10	19.3
Indiana	9	7	13	9.6	Loyola University, New Orleans	15	18	15	16.
Iowa	8	5	4	5.6	University of Maryland	16	35	21	24.
Kansas	0	0	28	9.3	Harvard University	5	0	12	5.6
Kentucky	22	11	0	11.	Tufts College	12	10	9	10.3
Louisiana	0	0	0	0	University of Detroit	24	11	10	15.
Maine	0	8	0	2.6	University of Michigan	24	15	16	18.3
Maryland	6	13	23	14.	University of Minnesota	6	6	21	11.
Massachusetts	3	3	3	3.	University of Kansas City	17	23	27	22.3
Michigan	25	10	15	16.6	St. Louis University	28	27	20	25.
Minnesota	1	3	8	4.	Washington University	27	10	24	20.3
Mississippi	5	13	0	6.	Creighton University	15	17	22	18.
Missouri	18	7	13	12.6	University of Nebraska	30	20	18	22.6
Montana	35	28	0	21.	Columbia University	7	4	7	6.
Nebraska	9	18	23	13.3	New York University	16	13	7	12.
Nevada	40	100	16	52.	University of Buffalo	20	9	4	11.
New Hampshire	30	7	75	37.3	Ohio State University	16	6	11	11.
New Jersey	51	41	35	42.3	Western Reserve University	20	14	10	14.6
New Mexico	72	42	0	38.	North Pacific College of Oregon	35	27	25	29.
New York	21	15	11	15.6	Temple University	27	28	20	25.
North Carolina	30	35	32	32.3	University of Pennsylvania	17	21	13	17.
North Dakota	0	0	0	0	University of Pittsburgh	19	15	22	18.6
Ohio	5	7	7	6.3	Meharry Medical College	66	62	39	55.6
Oklahoma	0	19	14	11.	University of Tennessee	13	6	41	20.
Oregon	15	24	30	23.	Baylor University	17	16	12	15.
Pennsylvania	6	1	9	5.3	Texas Dental College	25	6	23	18.
Rhode Island	0	0	0	0	Medical College of Virginia	17	22	4	14.3
South Carolina	47	24	13	28.	Marquette University	21	21	6	16.
South Dakota	29	0	100	43.					
Tennessee	0	16	50	22.	Canadian Dental Schools	37	32	19	29.3
Texas	37	31	32	33.3					
Utah	16	0	0	5.3	Other Foreign Dental Schools	100	43	100	81.
Vermont	44	25	0	23.					
Virginia	13	15	2	10.	Extinct Dental Schools	61	56	70	62.3
Washington	55	39	53	49.					
West Virginia	6	18	9	11.					
Wisconsin	5	0	4	3.					
Wyoming	50	0	50	33.3					

COMMITTEE ON LEGISLATION

AMERICAN MEDICAL ASSOCIATION *et al. vs.* UNITED STATES

THE following selections from the court decisions rendered in the recent cases involving the American Medical Association give the gist of the decisions.

SUMMARY OF CASE

December 1938: Indictment returned, accusing the American Medical Association, District of Columbia Medical Society, Harris County Medical Society and certain officers and members of these societies of conspiring to restrain trade.

July 1939: The American Medical Association contended that the indictment does not legally accuse it of a crime and the Federal District Court upheld the American Medical Association.

March 1940: The Federal Court of Appeals overruled the District Court and held that the indictment was legal in form.

COURT DECISION

The gist of this decision of the Court of Appeals is contained in the following paragraphs taken from the decision itself.

Group Health is an association of employees of certain executive departments of the Government employed in the District of Columbia, 80 per cent earning annual incomes not over $2,000. The association provides medical care and hospitalization to its members and their dependents on a risk sharing prepayment basis. Its funds are collected monthly in the form of dues. Medical care is provided by its medical staff, consisting of salaried physicians under the sole direction of a medical director. It provides a modern clinic and defrays, within certain limits, the expenses of hospitalization of its members and their dependents. The personal relationship ordinarily existing between doctor and patient exists between Group Health doctors and Group Health patients . . . The conspiracy was discussed at meetings held by members and committees of District Society, with the purpose of hindering Group Health from procuring and retaining on its medical staff qualified doctors by threatening with disciplinary action any members of District Society who should either join Group Health's staff or consult with physicians on its staff, and with the purpose of hindering and obstructing members of Group Health from obtaining access to hospital facilities and obstructing the doctors on its staff from treating and operating on patients in Washington hospitals, and for the purpose of inducing Washington hospitals to boycott Group Health and its doctors. A "white list" of approved organizations, groups and individuals was circulated, with the name of Group Health omitted—all for the purpose of threatening with disciplinary action any member of the District Society who worked for Group Health or consulted with any doctor on its staff and any hospital which admitted any Group Health doctor to its courtesy staff—the general purpose of the conspiracy being to restrain doctors in the District of Columbia in the pursuit of their calling and to restrain the hospitals in the operation of their business and to destroy Group Health in the performance of its functions.

The question then arose whether the practice of medicine is a trade within the meaning of Sec. 3 of the Sherman Act. The court discussed a long line of English and American cases and reached the following conclusion:

The indubitable effect of all these cases, English and American, is to enlarge the common acceptation of the word "trade" when embraced in the phrase "restraint of trade" to cover all occupations in which men are engaged for a livelihood. We think it makes no difference that, after the practice of medicine had been recognized as embraced in the doctrine of "restraint of trade," Davis V. Mason, *supra,* a number of judges preferred to speak in broader terms of "public policy" and the like, without using the word "trade." The foundation of the rule in restraint of trade cases is the rule of public policy, and always was from Mitchel *v.* Reynolds (1711) 1 P. Wms.

181, 24 Eng. Rep, 347, on down, without distinction based on type of occupation involved. . . . We think enough has been said to demonstrate that the common law governing restraints of trade has not been confined, as the defendants insist, to the field of commercial activity ordinarily defined as "trade," but embraces as well the field of the medical profession.

The case was then sent back to the District Court to be tried. The trial began in February 1941, and the following April the jury found the American Medical Association and the District of Columbia Medical Association guilty and all of the other defendants not guilty.

The A.M.A. and the D. of C. Medical Association then appealed to the Federal Court of Appeals, which in June 1942, upheld the conviction, saying in part:

The trade or commerce which was involved in the present case was of three kinds: (1) the making available and financing of medical and hospital services; (2) medical service itself, i.e., service rendered by medical doctors; (3) hospital service, i.e., service rendered by hospital staffs, and the use of hospital facilities. As we indicated in our earlier opinion, the common law recognized the practice of medicine as being trade. It may be regrettable that Congress chose to take over in the Sherman Act the common law concept of trade, at least to the extent of including therein the practice of medicine. Developments which have taken place during recent decades in the building of standards of professional education and licensure, together with self-imposed standards of discipline and professional ethics, have, in the belief of many persons, resulted in substantial differences between professional practices and the generally accepted methods of trade and business. As we pointed out in our earlier decision, the American Medical Association and other local medical associations have undoubtedly made a profound contribution to this development. However, our task is not to legislate or declare policy in such matters, but rather to interpret and apply standards and policies which have been declared by the legislature. . . .

The fact of commercial and business competition is the predominant note in the controversy which preceded the initiation of criminal prosecutions in these cases. One of the major purposes of Group Health Association was to provide low-cost medical service, on a prepayment basis. Appellants, in fact, recognize the existence of a controversy concerning this question.

The important question is, therefore, whether the methods used constituted improper restraints of competition, within the meaning of the statute in the trade or commerce of financing and making available all or any of the three several services to which reference has been made. And, as the prosecution in the present case is under Section 3 of the Act, no question of the interstate character of that trade or commerce is involved. Appellants urge a number of contentions to negate unlawful restraint. The first of these is that the controversy here involved is a labor dispute; hence, that appellants are excluded from the operation of the Sherman Act by virtue of provisions of the Clayton Act, 38 State 730, and of the Norris-LaGuardia Act, 29 USCA 101 et seq.

(The court then discussed the case at length from the standpoint of whether it involved a labor dispute and decided "A physician is not a workman or a laborer, as those words are known to the law, and his compensation is not wages . . . neither the Clayton Act nor the Norris-LaGuardia Act was intended to cover such a controversy as existed in the present case.")

Appellants reassert—in support of their contention that their conduct was not in restraint of trade—a proposition urged on the earlier appeal, that their conduct was no more than a reasonable regulation of the practice of medicine; and they rely upon the language of our earlier opinion: "If there is any justification for the restraint, so as to make it reasonable as a regulation of professional practice, it must be shown in evidence as a defense . . ." But in that same opinion, after recognizing the large and beneficent part which appellants have played in raising the standards of medical practice, and in contributing to the relief of the unfortunate and destitute—we also said: "Notwithstanding these important considerations, it cannot be admitted that the medical profession may through its great medical societies, either by rule or disciplinary proceedings, legally effectuate re-

straints as far reaching as those now charged." And we did not, by any means, declare the law to be—as appellants now assert—that a conspiracy "entered into with the object of properly and fairly regulating the practice of medicine" was not a violation of the Sherman Act. The prayer for instruction which appellants requested upon this point was contradictory on its face and was properly refused. Under no circumstances could the commission of crime be justified as a reasonable regulation of professional practice.

The wide scope of appellants' contention concerning their power to effect a reasonable regulation of the practice of medicine is revealed by proposed instructions and by their arguments on briefs which seem to assume for them powers of a state legislature to enact and enforce laws to require improvement of standards of professional practice. Thus they rely upon such cases as Semler *v.* Oregon State Board of Dental Examiners and Graves *v.* State of Minnesota, which involved the constitutionality of state statutes and in each of which the statute was upheld on the ground that it constituted a reasonable exercise of the police power of the state. Needless to say, appellants have no such power.

The situation which confronts appellants, and which they have sought to control, is not confined to the medical profession alone. Profound changes in social and economic conditions have forced members of all professional groups to make readjustments. The fact that these changes may result even in depriving professional people of opportunities formerly open to them does not justify or excuse their use of criminal methods to prevent changes or to destroy new institutions. Lawyers, too, have seen, during recent decades, large scale changes in their professional work. There was a time when lawyers worked entirely on fee or retainer in particular cases and controversies; now many of them are salaried employees on the staffs of large corporate industrial and financial organizations. Many of the simpler functions of business which once required the assistance of lawyers are now the routine work of better educated and more highly skilled business men; some of them law school graduates. Recent legislation has had the effect of removing from the field of judicial controversy and determination a large percentage of cases which at an earlier time constituted the mainstay of lawyers' practice. A good example is found in connection with accidents occurring in industrial employment. In some of this new legislation, representation by lawyers is expressly discouraged. In some of it, formal rules of pleading, practice and evidence—the lawyers' tools—dispensed with. There are some who regret and some who resent these changes. Over the years, as individuals and as members of professional associations, they have labored to prevent or minimize them. But they would not suggest that criminal conduct, as individuals or as associations, would be proper for such a purpose.

Professions exist because the people believe they will be better served by licensing especially prepared experts to minister to their needs. The licensed monopolies which professions enjoy constitute, in themselves, severe restraints upon competition. But they are restraints which depend upon capacity and training, not special privilege. Neither do they justify concerted criminal action to prevent the people from developing new methods of serving their needs. There is sufficient historical evidence of professional inadequacy to justify occasional popular protests. The better educated laity of today questions the adequacy of present-day medicine. Their challenge finds support, as indicated in the margin, from substantial portions of the medical profession itself. The people give the privilege of professional monopoly and the people may take it away.

A highly regimented military profession under strict governmental control; a ministerial or religious profession, without uniform standard or licensure; a large group of highly trained persons who serve the people as experts in news collection and dissemination, but who have never had professional standing, licensure or monopoly, these are all examples of alternative methods which the people have used to develop and control their professional groups.

In some instances, professional groups have been charged by legislative fiat with powers and duties concerning professional education, licensure, discipline, removal of licensees from practice, and other related subjects. In such cases, they act as agencies of government. Although some similar delegations of power have been made to the organized medical profession, there is no evidence of delegation of power to appellants, sufficient to authorize the conduct for

which they have been convicted. In the absence thereof, professional groups must abide by the general laws just as scrupulously as any private citizen or private corporation. It is in this setting that appellants were permitted to organize, to establish standards of professional conduct, to effect agreements for self-discipline and control. There is a very real difference between the use of such self-discipline and an effort upon the part of such associations to destroy competing professional or business groups or organizations. Again, to use the analogy of the legal profession, the activities of the American Medical Association in the present case more nearly resemble the situation which would exist if the American Bar Association or one of the state associations should undertake to destroy, by methods of criminal conspiracy, business organizations which employ lawyers, such as automobile associations, collection agencies, bankers' associations and title and trust companies. It is true that they have attempted, by means of actions to forbid unlawful practice of the law and by efforts to secure legislation, thus to prevent activities which they regarded as encroachments upon the practice of law. Such actions at law and such efforts to secure enactment of legislation are equally available to appellants. But there is a clearly defined line of demarcation here which must be observed if the penalties of the Sherman Act are to be avoided. As we suggested in our earlier opinion, appellants have open to them always the safer and more kindly weapons of legitimate persuasion and reasoned argument, as a means of preserving professional esprit de corps, winning public sentiment to their point of view or securing legislation. But they have no license to commit crime. When they go so far as to impose unreasonable restraints, they become subject to the prohibition of the Sherman Act. This, then, represents a limit to professional group activities. If it is desired to extend them beyond this point, legislation is required for that purpose. It may be desirable that this professional group shall be given such enlarged powers, but if so it will be necessary for the legislature to speak upon the subject rather than for the courts to recognize a privilege based upon preemption or usurpation.

The same general misconception seems to underlie the appellants' effort to show absence of restraint by contending that Group Health Association is an illegal organization or that it is engaged in illegal activities. It is elementary that a person is not privileged to kill another simply because the latter is a bad man. Neither can justification for the commission of a crime be found in the fact that its commission benefited the community; and evidence offered for such a purpose is properly excluded. Nor is the fact that a crime was committed with the intent to accomplish some ultimate good, an excuse for its commission; even if it was for the purpose of enforcing the law.

Appellants are not law enforcement agencies; they are charged with no duties of investigating or prosecuting, to say nothing of convicting and punishing. They have been given no power to require their members, or Group Health Association, to reveal the intimate details of their affairs, as was attempted in the present case. Except for their size, their prestige and their otherwise commendable activities, their conduct in the present case differs not at all from that of any other extra-governmental agency which assumes power to challenge alleged wrongdoing by taking the law into its own hands. Although extreme situations may seem sometimes to have required vigilant action where effective law enforcement by duly constituted officers had broken down or never been established; and although persons who reason superficially concerning such matters may find justification for extra-legal action to secure what seems to them desirable ends; this is not the American way of life. If Group Health Association is illegal, or is engaged in illegal activities, there is a method provided by law to determine the facts and to secure appropriate action. If further controls are needed in addition to those now available, the legislative method is the appropriate one to secure the desired end.

(The Court discussed technical objections to the verdict, dismissed all of them and closed its decisions with the following words: "As we read the record, the case was tried carefully and fairly; the jury was properly instructed, and the evidence was adequate to support the verdicts.")

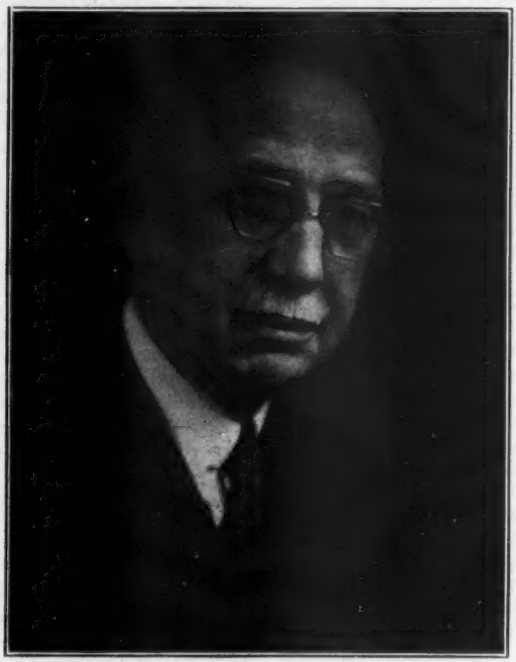
The United States Supreme Court granted a review limited to three legal questions and on January 18, 1943 sustained the foregoing decision of the Appellate Court.

OBITUARIES

WILLIAM HOFFMAN GARDINER LOGAN, D.D.S., M.D., LL.D., M.S.

1873-1943

On April 6, 1943, shortly after he had passed the milestone of three score and ten years, coronary disease abruptly terminated the life of William H. G. Logan. Stricken in the performance of duty, at a time when he was actively engaged in the solution of selective military service problems for dentistry and in carrying on his duties as dean of the Chicago College of Dental Surgery, Dental School of Loyola University, one of its most renowned and forceful leaders has been lost to dentistry.



WILLIAM HOFFMAN GARDINER LOGAN

Of Scotch-Irish ancestry, which figured prominently in the early political history of Illinois and of the Nation, Dr. Logan attended elementary and high school in Morrison, Ill. After his graduation from high school, he attended the Northern Illinois College at Fulton. He was graduated in dentistry in 1896 and in medicine in 1904. For the fourteen years immediately following his graduation, he practiced general dentistry. Since 1910, he had limited his practice to oral and plastic surgery. In 1896, he was appointed first surgical assistant to Truman W. Brophy, a position which he held until the death of Dr. Brophy, in 1928. In 1900, he was made associate professor of oral surgery at his Alma Mater; in 1902, professor of oral pathology; in 1920, professor of oral and plastic surgery and dean of the dental school—positions he graced until his death.

In June 1900, he was married to Florence Brophy, the gracious and charming daughter of Dr. Brophy. Her helpfulness and cooperation were a potent source of inspiration to Dr. Logan and helped to make possible his long series of achievements. To them was born one daughter, Jean Brophy (Mrs. Donald LaChance), who survives them, Mrs. Logan having passed away several years ago.

Soon after his graduation, Dr. Logan's aptitude for leadership became evident to his associates, and, within a comparatively short time, he was chosen to head professional organizations of national and international scope. Like all natural leaders, he possessed very definite qualities and convictions. First and foremost, he carefully studied every question and analyzed it thoroughly before making a decision. He was absolutely honest in the full meaning of the word and had the fortitude to fight to the last ditch if necessary in support of his convictions. He abhorred dishonesty as the one unforgivable sin. He never betrayed a confidence, and his advice was frequently sought by his friends because they had faith in his integrity, his sincerity and his good judgment.

From boyhood, Dr. Logan was a student. His acquisition of knowledge was not spectacular, but his thorough learning was acquired by long hours of application. His studious habits throughout his lifetime were remarkable in that early in life he set up for himself daily study periods; and much of the elegance and clarity of his scientific presentations were the result of midnight hours of studious concentration while his confrères slept.

Orderliness of thinking was another of his outstanding characteristics. From early manhood, he lived according to plan, and he possessed that rare ability of being able to step aside occasionally to analyze himself from the perspective of the outsider, in order to ascertain whether he himself was living up to his own standards. Meticulous thoroughness and punctuality were reflected in every action—in his work, his office, his dress and his personal conduct, and were responsible for his immaculate bearing and manner in the operating room, at social affairs and in professional gatherings, as well as when in his military uniform. His work as an instructor was characteristic and typical of the man; his presentations were clear, concise, exacting and stripped of all verbiage.

Leadership came to him as a spontaneous expression of the many societies of which he was a member. While a student in the Chicago College of Surgery, he was elected valedictorian of his class. He was later elected president of his dental school alumni association, of the Chicago Dental Society, of the American Dental Association, of the Seventh International Dental Congress and of the Fédération Dentaire Internationale, and the conclusion of each term of office saw a stronger and better society than when he accepted its leadership.

In recognition of his scientific and professional achievements, he was awarded the honorary degree of doctor of laws by Loyola University in 1926, and that of master of science by the University of Michigan in 1930. He was a fellow of the American College of Surgeons and of the American College of Dentists, a member of Omicron Kappa Upsilon (honorary dental), Pi Gamma Mu (honorary scientific) and Delta Sigma Delta fraternities, and a member of the Mystic Shrine.

His interest in international dental affairs and the promotion of international dental congresses gave him a world-wide acquaintance with dentists of all countries, with the result that he was made honorary member of a score of dental associations in other lands in addition to the many in America.

As a surgeon, the deftness of his manipulative dexterity in plastic operations was remarkable; but, even though intensely interested in the outcome of an

operation, he never forgot that the maimed, the sick and the afflicted were human beings who were entitled not only to an expenditure of his utmost skill, but also to every comfort within his ability. During the many years of his busy practice, it was his custom to return to the hospital each evening after his dinner and make bedside visitations to his patients before his own retirement in the hope that he might make their nights more comfortable.

Dr. Logan's scientific contributions to dentistry, surgery, education and research averaged more than one original essay per year for his forty-five years of practice; and, in their scope, they covered a wide range of subjects from jaw tumors and infections, cleft palate and lip, to the creation of the National Board of Dental Examiners. Many essayists have been known to prepare numerous papers on a limited number of subjects, but few have written with such thoroughness of understanding in a multitude of widely diversified fields.

His familiarity with the scientific approach to the solution of the unknown, and his faith in the possibilities of advancing dentistry's fund of scientific knowledge prompted him to encourage biologic research in the hope of increasing its humanitarian service. Through the financial assistance of a Chicago donor, who prefers to remain anonymous, he established the Foundation for Dental Research of the Chicago College of Dental Surgery in 1935. From this Foundation, notable contributions in the fields of anatomy, histology, dental pathology and oral surgery have already been made.

In April 1917, at the time when our entry into World War I appeared to be a certainty, Dr. Logan was appointed by Secretary of War Newton D. Baker to serve on the General Medical Board of the Council of National Defense as chairman of the Committee on Legislation and of the Committee on Dentistry. In August 1917, he was commissioned in the Medical Reserve Corps and assigned for active duty in the office of the Surgeon General in Washington. At that time, the Army Dental Corps consisted of a mere handful of men, none of whom had ever been stationed in the office of the Surgeon General, and all operating under the direct supervision of the Medical Corps. Realizing the necessity of a separate corps for dentistry, Dr. Logan was instrumental in securing the enactment of congressional legislation providing for an Army corps and the commissioning of a dentist for each 1,000 enlisted men. Through legislation, he also secured the exemption of dental students for military service. When the armistice was signed a year and a half later, Colonel Logan had built up a dental corps of 5,000 commissioned officers and made it possible for students in dental schools to continue their dental studies without interruption—a service for which dentistry should ever be grateful.

At the termination of hostilities, he returned to private practice, and, in 1920, became dean of the Chicago College of Dental Surgery. Within a year, he negotiated the merger whereby that school became the Dental Department of Loyola University. His interest in dental education was then accelerated, and much of his energy was directed to the advancement of dental education in the United States. His services as a member of the Dental Educational Council of America was valuable and his unusual executive ability has been evident in the work of the American Association of Dental Schools.

Dr. Logan was personally acquainted with more dentists than any other member of our profession. He was active in civic affairs in Chicago and was looked upon as a leader whenever questions bearing on professional policies were considered.

In the passing of Dr. Logan, oral and

plastic surgery has lost a master; dentistry, one of its best friends; education, a valuable dean, and the world, a leader whose brilliant achievements stand out as an inspiration to all men.

P. G. PUTERBAUGH.

ADDISON K. PARKS, D.D.S.
1875-1943

ADDISON K. PARKS was born June 7, 1875, in Perryville, Ky., the son of William Parks and Rebecca Karrick Parks. He was graduated in 1894 from Ewing Institute in Kentucky and received the degree of doctor of dental surgery from Vanderbilt University, Nashville, Tenn., four years later.

He began practice in 1899 at Bloomfield, Ky., and the following year married Julia Edna Dugan. Five years later, he moved to Montevallo, Ala. In 1913, he became president of the Alabama Dental Association, other honors following quickly. He was elected president of the Alabama Board of Dental Examiners in 1914. He became a fellow in the American College of Dentists. He was made grand master of the Alabama Auxiliary of Delta Sigma Delta dental fraternity in 1924. He was assigned a place in Who's Who, and he became a member and president (1929-1930) of the National Society of Denture Prosthetists, popularly called the "50" Club because of its rigidly limited membership.

Dr. Parks was in addition a member of Omicron Kappa Upsilon Fraternity, a Mason, Shriner, an Odd Fellow and a Kiwanian. He was a member of the Second Presbyterian Church.

He was at the head of his profession, for in him was combined years of excellent training and a great deal of native ability and talent. But more than this, he was a much beloved man. He had a way about him that was dignified, but kind and wholesome. Though he was of a retiring nature, his personal magnetism was such that he inspired the greatest confidence. Patients came from abroad and from all over the United States to consult him.

As a research worker in prosthetics, his work was unparalleled. He contributed much to science, particularly in his work on the temporomandibular joint and on the middle ear, to clarify the relation between dental conditions and deafness. The results of his work he was quick to share with fellow dentists through his writings. He was a collaborator in Nichol's "Prosthetic Dentistry" and a frequent contributor to the *Dental Digest*.

Dr. Parks died January 5, 1943.

DEATHS

ABEL, L. HOSFORD, White Plains, N. Y.; New York College of Dentistry, 1896; died April 9; aged 69.

ADAMS, W. C., Moundsville, W. Va.; Virginia School of Dentistry, 1901; died March 24.

AKERS, CLAYTON M., Bakersfield, Calif.; University of Southern California, College of Dentistry, 1922; died April 1.

BALDWIN, FRANK G., Orange, Conn.; Philadelphia Dental College, 1896; died April 18; aged 69.

BANNISTER, EDWARD, Chicago, Ill.; Chicago College of Dental Surgery, 1919; died March 24; aged 65.

BAUMAN, HERMAN H., Cleveland, Ohio; University of Pittsburgh, School of Dentistry, 1920; died March 24; aged 44.

BAUMGARTNER, ARTHUR W., Chicago, Ill.; Chicago College of Dental Surgery, 1919; died April 11; aged 44.

BELL, GEORGE R., Punxsutawney, Pa.; Philadelphia Dental College, 1889; died March 22; aged 85.

BOONE, GEORGE M., Warren, Ohio; Pennsyl-

vania College of Dental Surgery, 1900; died April 18; aged 70.

BORGWARDT, GEORGE H., Fairmont, Minn.; University of Minnesota, College of Dentistry, 1907; died March 18; aged 57.

BROOKINS, JOHN M., West Alexandria, Ohio; died April 16; aged 86.

BROWN, J. ADDISON, Champaign, Ill.; Illinois School of Dentistry, 1899; died April 17; aged 64.

BRYAN, NORMAN LUTHER, Orlando, Fla.; Southern Dental College, 1905; died March 31; aged 65.

BURNHEIM, JULIAN R., San Francisco, Calif.; died March 16; aged 65.

CARDWELL, LOUIS P., Chicago, Ill.; died April 22; aged 70.

CONNER, WILLIAM HENRY, San Jose, Calif.; Baltimore College of Dental Surgery, 1891; died April 1; aged 79.

COOPER, SIMON E., Syracuse, N. Y.; University of Buffalo, School of Dentistry, 1918; died April 4; aged 48.

COXETER, JOHN S., Newtonville, Mass.; Harvard Dental School, 1899; died April 22; aged 69.

CURTIS, FREDERICK ARTHUR, San Jose, Calif.; University of California, College of Dentistry, 1905; died March 11; aged 61.

DASHWOOD, PERCY T., Atlanta, Ga.; Atlanta Dental College, 1898; died April 6; aged 81.

DAVIS, B. G., Stella, Nebr.; Creighton University, College of Dentistry, 1916; died April 15.

DAVIS, THOMAS JEFFERSON, St. Louis, Mo.; St. Louis University School of Dentistry, 1925; died March 13; aged 47.

DEXTER, CLEMENT JEROME, Rockwell, Iowa; State University of Iowa, College of Dentistry, 1900; died March 25; aged 63.

DOSEK, JAMES L., David City, Nebr.; University of Nebraska, College of Dentistry, 1927; died March 13; aged 42.

DRISCOLL, JOHN B., Butte, Mont.; North Pacific College of Oregon, School of Dentistry, 1923; died March 23.

DUFFEY, ROBERT F., Cleveland, Ohio; Cincinnati Dental College, 1900; died April 8; aged 65.

ECKERT, JOSEPH A., Washington, D. C.; Georgetown University School of Dentistry, 1911; died April 13; aged 63.

ELDER, JOHN EMIL, Eldorado, Ill.; Washington University School of Dentistry, 1910; died April 2; aged 55.

FOWLKES, C. BENJAMIN, Mobile, Ala.; German-American Dental College, 1890; died March 10.

FREEMAN, GEORGE, Seattle, Wash.; University of Michigan, School of Dentistry, 1900; died April 16; aged 79.

GARTRELL, JULIAN, Washington, D. C.; Baltimore College of Dental Surgery, 1888; died March 28; aged 82.

GILLESPIE, J. B., Enid, Okla.; formerly of Ringwood, Okla.; died January 25; aged 86.

GODLOVE, LESTER L., Wellman, Iowa; State University of Iowa, College of Dentistry, 1901; died recently; aged 65.

HARRISON, M. ALLYN, JR., Washington, D. C., Georgetown University, School of Dentistry, 1910; died February 17; aged 60.

HAUSELT, CHARLES P., San Francisco, Calif.; University of California, College of Dentistry, 1895; died March 19; aged 64.

HENRY, EDWARD E., Kingston, N. Y.; Harvard Dental School, 1897; died April 22.

HILL, WILLIAM B., Great Barrington, Conn.; New York College of Dentistry; died April 14; aged 78.

HOCKING, TOBIAS, West Allis, Wis.; Chicago College of Dental Surgery, 1901; died April 12.

HOUSER, W. O., Lincoln, Ill.; Chicago College of Dental Surgery, 1893; died April 19; aged 70.

HOWELL, ROBERT BROWN, Ann Arbor, Mich.; University of Michigan, School of Dentistry, 1898; died December 26; aged 66.

KENNEDY, CHARLES T., Lieutenant Colonel, U. S. Army Dental Corps, Fort Meade, Md.; University of Buffalo School of Dentistry, 1923; died March 24; aged 48.

KERNS, JOHN L., Salamanca, N. Y.; University of Buffalo, School of Dentistry, 1918; died March 14.

KRON, OTTO AUGUST, Kenmare, N. D., Northwestern University Dental School, 1905; died recently; aged 61.

LAMB, D. GORDON, Indianapolis, Ind.; Indiana University School of Dentistry, 1922; died January 26.

LURTING, ALEXANDER N., Mars, Pa.; University of Pittsburgh, School of Dentistry, 1907; died April 18; aged 64.

MACDONALD, WILLIAM J., Rochester, N. Y.; died March 25; aged 45.

CURRENT LITERATURE

Nutrition as It Affects the Teeth

By A. W. Mann

Oral manifestations usually accompany systemic changes associated with nutritional deficiencies. A deficiency of vitamins A, C and D, calcium and phosphorus affects both enamel and dentin during growth and development, but not enamel after development. The presence in the diet of adequate amounts of mineral elements and vitamins is conceded to be of some value in preventing dental caries. The number of acid-forming organisms in the mouth can be lowered by decreasing the amount of carbohydrate intake, especially simple sugars. The oral soft tissues are influenced adversely by deficiencies of vitamin C and nicotinic acid, periodontoclasia being one possible result. Vincent's infection subsides in cases of pellagra under adequate nicotinic acid therapy. However, vitamin therapy does not seem to be of value unless the pathologic condition is the result of vitamin deficiency. —*M. Clin. North America,* 27:545, March 1943.

David B. Scott.

On the Nature of Local Anesthesia

By K. V. Thimann

A definite relation exists between the anesthetic action and the chemical structure of anesthetic compounds. The molecular structures of the known local anesthetics resemble that of acetylcholine, $(CH_3OH)(CH_3)_2N(CH_2)_2$-O-CO-$CH_3$. The drugs owe their property to a competition with acetylcholine for the receptive substance at nerve endings, which is the normal substrate upon which acetylcholine functions. This concept is supported by experimental data and by analyses from other fields of biochemistry.—*Arch. Biochem.,* 2:87, April 1943.

Peter P. Dale.

A Summary of Treatment of Periodontal Diseases

By H. M. Goldman

The treatment of periodontal diseases consists of three phases: removal of the etiologic factors, correction of symptoms and institution of procedures for the maintenance of health. Thorough elimination of direct irritants, such as supragingival calculus, and polishing the teeth will usually alleviate some etiologic conditions and symptoms. Many suppurative processes will be relieved without further treatment. Subgingival curettage, the flap operation and gingivectomy are the treatments of choice in the eradication of deep periodontal pockets. In performing the flap operation, the mouth should first be cleaned and made as aseptic as possible; the interproximal tissues separated into two parts so that flaps may be retracted labially and lingually, and the teeth then cleaned and the epithelial lining and inflammatory granulomatous tissue removed. Gingivectomy can be accomplished surgically, chemically or electrosurgically, and is indicated when subgingival curettage has failed or the pocket is inaccessible for instrumentation. The restoration of normal occlusal function by proper operative and prosthetic procedures is important, as are home care and the use of the toothbrush. When periodontal disease accompanies systemic disorder, local treatment remains essential.—*Am. J. Orthodontics,* 29:183, April 1943.

S. J. Fanale.

Production of Carious Lesions in the Molar Teeth of Hamsters

By F. A. Arnold, Jr.

The production of dental caries in the albino rat, commonly employed for this purpose, is not strictly analogous to the lesion in man. In the Syrian hamster, however, decay has been observed which is strikingly similar to human caries. In the albino rat, the diet must contain coarsely ground corn for caries to be produced. It is suggested that the phenomenon involves abrasion and fracture of the enamel by the particles, and their impaction in occlusal grooves, resulting in acid formation. Molars of the albino rat are characterized by deep

occlusal crevices; which increases their susceptibility to caries. Grooves in the molars of hamsters, on the other hand, are shallow and do not favor extensive impaction or retention, yet the teeth are much more susceptible to decay than those of the albino rat. Both occlusal and cervical caries has been observed in the hamster, but only occlusal lesions in the albino rat. In the hamster, a finely divided cornstarch diet produces considerably more caries than a diet of coarse corn. There is evidence that the study of caries in the hamster may be of considerable importance in evaluating factors in the production of human dental decay.—*Pub. Health Rep.*, 57:1599, October 23, 1942.

DAVID B. SCOTT.

Comparative Study of Oral Changes in Dogs Due to Deficiencies of Pantothenic Acid, Nicotinic Acid and Unknowns of the B Vitamin Complex

By HERMANN BECKS ET AL.

DEPRIVATION of various fractions of the vitamin B complex in a pure strain of dogs produced severe pathologic changes similar to those observed in oral tissues of human beings. Nicotinic acid deficiency over a period of three years caused marked paradental disease. Deficiency in one filtrate fraction of the complex seriously impaired the health of growing dogs. The oral epithelium of these animals degenerated, showing hyperkeratosis and enlargement of the epithelial rests. Necrosis and desquamation of the epithelium apparently is a specific result of prolonged filtrate fraction deficiency. Alveolar bone became porous and showed progressive marginal atrophy resembling atrophic paradentosis in man. Pantothenic acid therapy was most effective in preventing pathologic changes, although such prevention was not complete. The curative effect of yeast filtrate in a dog deficient in the filtrate fraction, but not in nicotinic acid, was demonstrated in that no pathosis was detected at necropsy.—*Am. J. Orthodontics*, 29:183, April 1943.

E. GUNNAR JOHANSSON.

Vitamin C and Infection

THOUGH optimum nutrition appears to increase the resistance to infection, few observations on human beings have been made in an attempt to credit this effect to specific vitamins or to vitamin levels as correlated with specific immunologic reactions. Glazebrook and Thomson (1942) found that administration of ascorbic acid to 1,500 schoolboys, aged 15 to 20, on a vitamin C deficient diet, reduced materially the incidence of tonsillitis, pneumonia and acute rheumatism, but had no effect on the common cold. The results do not justify ascorbic acid therapy in those already receiving the "accepted" requirements, nor do they indicate that vitamin C plays a major rôle in resistance to disease. A wide variation in vitamin C susceptibility exists. Scurvy may first be indicated by gingivitis, which may also be a result of purely local conditions, and early scorbutic anemia may actually be associated with suboptimal iron intake. Of 300 individuals with gingivitis and low ascorbic acid intake, 273 were cured of the gingivitis by local treatment only, whereas only twenty-seven required vitamin C to complete healing. Apparently, there are a great many factors other than vitamin C deficiency in the production of the physical signs of scurvy. These factors may be ruled out by carefully controlled clinical experimentation. —*Nutrition Rev.*, 1:202, May 1943.

DAVID B. SCOTT.

Production of Acids from Glucose by Dental Plaque Material

By J. A. MUNTZ

SUFFICIENT plaque material was removed from the teeth of each of thirteen individuals to provide a moderately heavy suspension in 2 cc. of distilled water. The samples were homogenized and aliquots incubated with 0.1 per cent glucose for one half hour. One aliquot of each sample was incubated aerobically and, in four cases, anaerobically. Analysis was made for glucose and lactic acid before and after incubation. The ratio of moles of lactic acid produced to moles of glucose consumed was determined. Unbuffered solutions were incubated; hence, the pH fell. The only buffering action was derived from the plaque material. Apparently, rapid destruction of lactic acid from glucose by the action of bacteria in dental plaque material occurs chiefly in a neutral medium under aerobic conditions. Anaerobically, lactic acid tends to accumulate, probably because its destruction is greatly

retarded. The rate of lactate breakdown depends on the concentration of plaque material. Concomitant with lactic acid formation and destruction was a slow, but steady production of steam-volatile acids, such as acetic acid and one that in reaction resembled propionic acid. Formic acid appeared in extremely small quantities. Some non-volatile acids as yet unidentified were also produced.—*J. Biochem.*, 148:225, April 1943.

PETER P. DALE.

Actinomycosis. A Report of Twenty-Six Cases

By D. E. ZISKIN, J. SHOHAM and J. M. HANFORD

ACTINOMYCOSIS may attack any tissue or organ of the body, but cervicofacial infection involving the mandible is the most common form. The infection is chronic, extending over months or years. It burrows into subcutaneous, submucous and subperitoneal connective tissues, gradually working to the surface or into a body cavity. In the jaw, suppuration almost always develops toward the skin, pointing into the mouth being infrequent. The abscess fluid resembles the pus of staphylococcic lesions, with the exception that necrotic tissue is present instead of polymorphonuclear leukocytes. Diagnosis is based on the clinical picture, the presence of sulfur granules in the pus, smears and cultures of the fungi. Actinomycosis may simulate tuberculosis, tertiary syphilis and neoplastic processes. The ideal treatment is complete excision at an early stage. Also effective are iodides and iodine preparations, x-ray and radium treatment, autogenous vaccines and a high vitamin diet. The disease has no geographic limitations, its source being infection by the ray fungus, a normal inhabitant of the mouth.—*Am. J. Orthodontics*, 29:193, April 1943.

S. J. FANALE.

A Study of General Anesthesia as Employed in Dentistry

By F. J. SMITH

IN general anesthesia, an adequate consideration and consultation and the individual evaluation of each case are necessary to determine the final choice of management. It is important to realize the anesthetic risk involved, especially when a complete physical examination has not been made. From the moment administration of an anesthetic is begun until consciousness is regained, the patient's safety is in the hands of the anesthetist. Satisfactory results require proper preparation of the patient. For major oral surgery, he must be hospitalized and given a thorough physical examination. The anesthetist must be cognizant of the patient's mental state, since fear and anxiety exert a deleterious effect on the body, comparable to that of trauma. Premedication is necessary to promote a favorable mental attitude. Many of the contraindications for the use of general anesthetic agents in the dental office may be ignored or minimized in hospital practice, this being especially true of ether, which is best applied through endotracheal or endopharyngeal insufflation. Owing to its advantages, ether has gained great favor in extensive jaw surgery and in all major oral surgery in children. Vinethene has been used to replace ethyl chloride, for added safety. Intravenous anesthesia should not be used in children under 10 years or in patients suffering from any disease accompanied by dyspnea.—*Bull. Massachusetts D. Soc.*, 19:16, April 1943.

S. J. FANALE.

Failure of Riboflavin Therapy in Patients with the Accepted Picture of Riboflavin Deficiency

By T. E. MACHELLA and P. R. MCDONALD

IN the literature, certain clinical phenomena have been attributed to a deficiency in riboflavin. These are cheilosis; dermatitis in the nasolabial fold, on the alae nasae, in the ears, etc.; vascularization of the cornea; glossitis, and pemphigus vulgaris. Twenty cases with symptoms ascribed to riboflavin deficiency were studied and treated with a synthetic riboflavin preparation. When no result was obtained after a certain period, dosage was increased, and if then without effect, the riboflavin was suspended and separate courses of pyridoxine, nicotinic acid, ascorbic acid or the whole B vitamin complex were administered. Cases of cheilosis were non-specific, responding variously to each agent. In view of conflicting data in the literature and the experience gained in this study, serious doubt exists relative to the syndrome of ariboflavinosis.—*Am. J. M. Sc.*, 205:214, February 1943.

J. LAZANSKY.

ANNOUNCEMENTS

ANNOUNCEMENTS must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

CALENDAR OF MEETINGS

AMERICAN DENTAL ASSISTANTS ASSOCIATION, Cincinnati, Ohio, October 11-14.

AMERICAN SOCIETY OF ORAL SURGEONS AND EXODONTISTS, Cincinnati, Ohio, October 8-9.

DISTRICT OF COLUMBIA DENTAL SOCIETY, second and fourth Tuesdays in each month, from October to June, at the United States Public Health Service Auditorium, Washington.

MONTREAL (CANADA) DENTAL CLUB, October 20-22.

NEW YORK SOCIETY OF ORTHODONTISTS, New York, November 8-9.

ROOT CANAL THERAPY ORGANIZATION, Chicago, February 1944.

STATE SOCIETIES

June

Colorado, at Denver (17-19)
District of Columbia, at Washington (8)
Idaho, at Twin Falls
Nevada, at Reno
New Hampshire, at Manchester (9)
New Mexico, at Carlsbad
Oregon, at Portland (10-12)
Utah, at Salt Lake City (3-5)
Wyoming, at Casper

September

Southern California, at Los Angeles (13-15)

November

Ohio, at Cleveland (7-10)

January 1944

Rhode Island, at Providence

STATE BOARDS OF DENTAL EXAMINERS

California, at San Francisco, October 25 and at Los Angeles, November 29. Kenneth I. Nesbitt, 515 Van Ness Ave., San Francisco, Secretary.

Connecticut, at Hartford, June 15-19. Clarence G. Brooks, 302 State St., New London, Recorder.

Delaware, at Wilmington, June 15-17 (dental hygienists). Charles R. Jefferis, Medical Arts Bldg., Wilmington, Secretary.

Indiana, at Indianapolis, August 23-26. Carl A. Frech, Gary State Bank Bldg., Gary, Secretary.

Iowa, at Iowa City, July 26-30. Harry G. Bolks, Sioux City, Secretary.

Maine, at Augusta, June 21-22. Carl W. Maxfield, 31 Central St., Bangor, Secretary.

New Jersey, June 28-July 2. J. Frank Burke, 150 E. State St., Trenton, Acting Secretary.

New Mexico, at Santa Fe, June 14-17. J. J. Clarke, Artesia, Secretary.

North Dakota, at Fargo, July 12-15. R. A. Andrews, Carrington, Secretary.

South Dakota, at Sioux Falls, June 20-24. T. E. Barrington, Rapid City, Secretary.

Texas, at Dallas, June 7-10. Carl C. Hardin, Jr., 311 Norwood Bldg., Austin, Executive Secretary.

Vermont, at Montpelier, June 28-30. Charles I. Taggart, 139 Bank St., Burlington, Secretary.

West Virginia, at Charleston, June 28. R. H. Davis, 510 Goff Bldg., Clarksburg, Secretary.

AMERICAN DENTAL ASSISTANTS ASSOCIATION

THE nineteenth annual session of the American Dental Assistants Association will be held in Cincinnati, Ohio, October 11-14, with headquarters at the Hotel Gibson.

AILEEN M. FERGUSON,
General Secretary,
709 Centre St.,
Jamaica Plain, Mass.

AMERICAN SOCIETY OF ORAL SURGEONS AND EXODONTISTS

THE twenty-fifth annual meeting of the American Society of Oral Surgeons and Exodontists will be held at the Netherland-

Plaza Hotel, Cincinnati, Ohio, October 8-9.

HARRY BEAR, *Secretary,*
410 Professional Bldg.,
Richmond, Va.

MONTREAL DENTAL CLUB FALL CLINIC

THE Nineteenth Annual Fall Clinic under the auspices of the Montreal Dental Club will be held at the Mount Royal Hotel, Montreal, Canada, October 20-22. For further information, apply to

M. L. DONIGAN, *Director,*
Drummond Medical Bldg.,
Montreal.

NEW YORK SOCIETY OF ORTHODONTISTS

THE fall meeting of the New York Society of Orthodontists will be held at the Hotel Waldorf-Astoria, New York, November 8-9.

NORMAN L. HILLYER, *Secretary,*
Professional Bldg.,
Hempstead, N. Y.

ROOT CANAL THERAPY ORGANIZATION

AT the Midwinter Meeting of the Chicago Dental Society, a national group for the study of root canal therapy was organized. W. Clyde Davis was made president, and John H. Hospers, secretary-treasurer. Committees were appointed to draw up a constitution and to select a name, to be submitted at the next regular meeting in Chicago in February 1944. It is hoped that all those who are interested in this fundamental phase of dentistry will associate themselves with the group. Those joining before the final organization will be considered charter members. Annual dues were temporarily set at $2. All correspondence should be addressed to

JOHN H. HOSPERS, *Secretary,*
25 E. Washington St.,
Chicago, Ill.

SOUTHERN CALIFORNIA STATE DENTAL ASSOCIATION

THE next annual meeting of the Southern California State Dental Association will be held in Los Angeles, at the Ambassador Hotel, September 13-15.

ROBERT L. BORLAND, *Secretary,*
602 Chapman Bldg.,
Los Angeles.

COLORADO STATE DENTAL ASSOCIATION

THE next annual meeting of the Colorado State Dental Association will be held in Denver, at the Cosmopolitan Hotel, June 17-19.

CHARLES K. PHILLIPS, *Secretary,*
529 Majestic Bldg.,
Denver.

DISTRICT OF COLUMBIA DENTAL SOCIETY

THE next annual meeting of the District of Columbia Dental Society will be held in Washington, June 8.

J. WALTER BERNHARD, *Secretary,*
1835 Eye St., N. W.,
Washington.

NEVADA STATE DENTAL ASSOCIATION

THE next annual meeting of the Nevada State Dental Association will be held in Reno, in June.

LOUIS M. NELSON, *Secretary,*
Reno.

NEW HAMPSHIRE DENTAL SOCIETY

THE next annual meeting of the New Hampshire Dental Society will be held in Manchester, June 9.

FLOYD E. WILLIAMS, *Secretary,*
Manchester.

NEW MEXICO STATE DENTAL SOCIETY

THE next annual meeting of the New Mexico State Dental Society will be held in Carlsbad in June.

J. S. EILAR, *Secretary,*
Albuquerque.

OHIO STATE DENTAL SOCIETY

THE next annual meeting of the Ohio State Dental Society will be held in Cleveland, November 7-10.

EDWARD C. MILLS, *Secretary,*
255 E. Broad St.,
Columbus.

OREGON STATE DENTAL ASSOCIATION

THE next annual meeting of the Oregon

State Dental Association will be held in Portland, June 10-12.

F. W. HOLLISTER, *Secretary,*
Selling Bldg.,
Portland.

RHODE ISLAND STATE DENTAL SOCIETY

THE next meeting of the Rhode Island State Dental Society will be held in Providence in January 1944.

CHARLES F. MCKIVERGAN,
Secretary Pro Tem.,
102 Waterman St.,
Providence.

UTAH STATE DENTAL ASSOCIATION

THE next annual meeting of the Utah State Dental Association will be held in Salt Lake City, June 3-5.

C. G. GREEN, *Secretary,*
1001 Boston Bldg.,
Salt Lake City.

WYOMING STATE DENTAL ASSOCIATION

THE next annual meeting of the Wyoming State Dental Association will be held in Casper in June.

J. D. MCNIFF, *Secretary,*
Laramie.

BOARD OF DENTAL EXAMINERS OF CALIFORNIA

THE next examinations to be conducted by the Board of Dental Examiners of California for licensure in the State of California will be held in San Francisco commencing October 25 and in Los Angeles commencing November 29. All credentials must be in the office of the secretary, Room 203, 515 Van Ness Ave., San Francisco, at least twenty days prior to the examinations. Address all communications to

KENNETH I. NESBITT, *Secretary,*

CONNECTICUT DENTAL COMMISSION

THE Connecticut Dental Commission will meet in Hartford, June 15-19, for the examination of applicants for license to practice dentistry and dental hygiene and to transact any other business proper to come before it. Applications should be in the hands of the recorder at least ten days before the meeting. For application blanks and further information, apply to

CLARENCE G. BROOKS, *Recorder,*
302 State St.,
New London.

DELAWARE STATE BOARD OF DENTAL EXAMINERS

THE next examinations conducted by the Delaware State Board of Dental Examiners will be held June 15-17 for applicants for licenses as dental hygienists. All examinations will be held in Wilmington.

CHARLES R. JEFFERIS, *Secretary,*
Medical Arts Bldg.,
Wilmington.

INDIANA STATE BOARD OF DENTAL EXAMINERS

THE next examination for a license to practice dentistry in Indiana will be held in Indianapolis, August 23-26. All credentials must be in the hands of the secretary at least ten days prior to the date of the examination. For application blanks and information, address

CARL A. FRECH, *Secretary,*
Gary State Bank Bldg.,
Gary.

IOWA STATE BOARD OF DENTAL EXAMINERS

(Change of Date)

THE Iowa State Board of Dental Examiners will hold its next examination at the College of Dentistry, State University of Iowa, Iowa City, July 26-30. Application with necessary fee must be in the hands of Mr. H. W. Grefe, director of licensure and registration, Iowa State Department of Health, Des Moines, fifteen days before the examination.

HARRY G. BOLKS, *Secretary,*
923 Badgerow Bldg.,
Sioux City.

MAINE STATE BOARD OF DENTAL EXAMINERS

THE next meeting of the Maine State Board of Dental Examiners will be held June 21-22 at the State House, Augusta. Applications with necessary fee must be in the hands of the secretary at least ten days before the date of the examination. Address all communications to

CARL W. MAXFIELD, *Secretary,*
31 Central St.,
Bangor.

NEW JERSEY STATE BOARD OF REGISTRATION AND EXAMINATION IN DENTISTRY

THE State Board of Registration and Examination in Dentistry of New Jersey will hold its next regular examinations commencing June 28 and continuing for five days. On application to the secretary, a copy of the requirements and rules, instruction sheet and preliminary application will be forwarded. Candidates were required to file the preliminary application blank, with the examination fee of $25, on or before March 15. Future schedules will be announced.

J. FRANK BURKE, *Acting Secretary,*
150 E. State St.,
Trenton.

NEW MEXICO BOARD OF DENTAL EXAMINERS

THE New Mexico Board of Dental Examiners will hold its next meeting June 14-17 in Santa Fe. For further information, address

J. J. CLARKE, *Secretary,*
Artesia.

NORTH DAKOTA STATE BOARD OF DENTAL EXAMINERS

THE North Dakota State Board of Dental Examiners will hold its next examination in the Gardner Hotel, Fargo, July 12-15. For further information and applications, address

R. A. ANDREWS, *Secretary,*
Carrington.

SOUTH DAKOTA STATE BOARD OF DENTAL EXAMINERS

THE South Dakota State Board of Dental Examiners will conduct examinations for a license to practice dentistry or to practice dental hygiene in South Dakota June 20-24 at Sioux Falls. For further information and applications, address

T. E. BARRINGTON, *Secretary,*
Rapid City.

TEXAS STATE BOARD OF DENTAL EXAMINERS

THE Texas State Board of Dental Examiners will examine all graduates for license to practice dentistry in Texas, June 7-10, with headquarters at the Baker Hotel, Dallas. For further information, address

CARL C. HARDIN, JR.,
Executive Secretary,
311 Norwood Bldg.,
Austin.

VERMONT STATE BOARD OF DENTAL EXAMINERS

THE Vermont State Board of Dental Examiners will meet for the purpose of examining candidates in dentistry and dental hygiene, June 28-30, at the State House, Montpelier.

CHARLES I. TAGGART, *Secretary,*
139 Bank St.,
Burlington.

WEST VIRGINIA STATE BOARD OF DENTAL EXAMINERS

THE next meeting of the West Virginia State Board of Dental Examiners will be held in Charleston, commencing June 28. Applicants for license to practice dentistry or dental hygiene will be examined. Applications must be in the hands of the secretary ten days before the meeting. For application blanks and information, apply to

R. H. DAVIS, *Secretary,*
510-515 Goff Bldg.,
Clarksburg.

DIRECTORSHIPS OPEN IN WEST VIRGINIA STATE HEALTH DEPARTMENT

UNASSEMBLED examinations are announced for positions in the West Virginia State Health Department. Applications will be accepted continuously, but new registers will be established from applicants who file no later than June 26. Positions for which applications are now accepted, together with salary ranges, are as follows: Director, Bureau of Dental Hygiene, $3,840-$4,500; Director, Public Health Education, $2,640-$3,240. Appointments may be made at above the minimum salaries. Residence in West Virginia has been waived in consideration of applicants for these positions. Address communications to

ROBERT F. BINGHAM, *Supervisor,*
212 Atlas Bldg.,
Charleston.

DENTAL INTERNSHIPS

THE Greater New York Conference of Hospital Dental Services, comprised of a group of men who are chiefs of dental services, would like to aid those men seeking dental internships in hospitals in the metropolitan area. Those who are not in the Army or the Navy and who are desirous of obtain-

ing internships should communicate with

MARY E. REILLY, *Secretary,*
386 Fourth Ave.,
New York, N. Y.

VOLUNTEERSHIPS AND EXTERNSHIPS, BRONX HOSPITAL

THERE are several volunteerships and externships available for recent graduates at the dental clinic, Bronx Hospital, in the following departments: oral surgery and exodontia, operative dentistry, orthodontia, surgical periodontia and root canal therapy. Applicants address David Wurzel, director of the Dental Department, Bronx Hospital, 169th St. & Fulton Ave., Bronx, New York.

RESIDENCIES AND INTERNSHIPS

THERE will be available July 1 at the Sea View Hospital, New York, N. Y., two dental residencies and two dental internships for a one year period. The Sea View Hospital, probably the largest tuberculosis hospital in the world, offers exceptional opportunities in most phases of dentistry. The dental residencies include a stipend of $1,200 annually plus maintenance; the internships, a stipend of $15 monthly plus maintenance. Application forms can be obtained from the medical superintendent, Sea View Hospital, Staten Island, New York.

RALPH HOWARD BRODSKY, *Director,*
Division of Oral Surgery.

CARNEGIE FELLOWSHIPS FOR RESEARCH AND GRADUATE WORK IN THE DENTAL SCIENCES

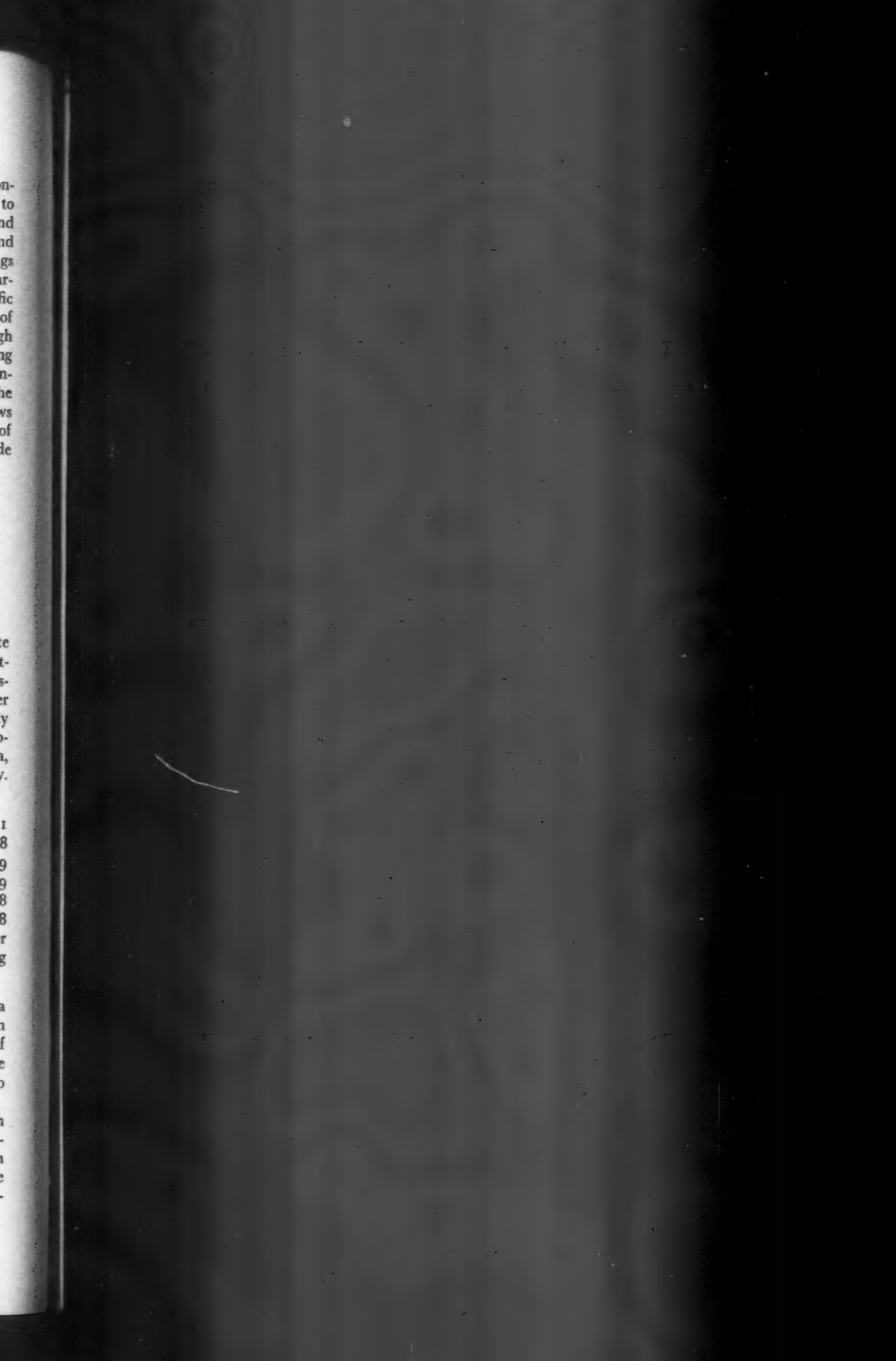
AIDED by the Carnegie Corporation of the New York and the Eastman Dental Clinic, the School of Medicine and Dentistry of the University of Rochester offers scholarships paying $1,200-$1,800 per annum to well-trained dental graduates who are interested in research or who desire special training in the basic medical sciences as an aid to dental teaching or practice. A few fellowships also offer part-time training in oral surgery. On appointment, the applicant is given the title of Fellow in Dentistry and, according to his interest, works as a graduate student in one of the departments of the medical schools. Here, excellent laboratory facilities, adequate direction and close contact with various investigations related to medicine and dentistry help his research and study. Fellows are encouraged to attend medical classes, seminars and staff meetings and, when opportunity presents itself, to participate in class instruction and scientific meetings. Contact with the problems of clinical dentistry may be maintained through the Oral Surgery Clinic of the Strong Memorial Hospital and the Rochester Dental Dispensary. With the approval of the Graduate Council of the university, Fellows may prepare themselves for the degree of M.S. or Ph.D. Applications should be made to

GEORGE H. WHIPPLE, *Dean,*
Rochester, N. Y.

OHIO STATE UNIVERSITY POSTGRADUATE COURSE IN DENTISTRY

THE College of Dentistry of Ohio State University, at Columbus, offers postgraduate courses in dentistry that are especially designed for the general practitioner who may wish to amplify his training in any of the following fields: oral surgery, prosthodontia, x-ray, crown and bridge, periodontia, operative dentistry and root canal therapy. The dates of the courses are as follows:

X-ray	June 7 to 11
Oral surgery	June 14 to 18
Prosthodontia	June 14 to 19
Crown and bridge	June 14 to 19
Operative dentistry	June 14 to 18
Root canal therapy	June 14 to 18
Periodontia	One day per week for ten weeks beginning June 23

The fees for these courses will be $50 a week, with the registration limited to ten men in each course, with the exception of prosthodontia, which will be $100 for the week's course, with registration limited to five.

It is the aim of these courses to teach new technics as well as to review the fundamentals. Further information and application blanks can be secured from the office of the dean, College of Dentistry, Ohio State University, Columbus.